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THE SHOVEL-NOSED SNAKE, CHIONACTIS WITH DESCRIPTIONS OF TWO NEW SUBSPECIES

BY

Laurence M. Klauber

Curator of Reptiles and Amphibians, San Diego Society of Natural History

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COMMITTEE ON PUBLICATION

Joshua L. Baily

Carl L. Hubbs

Laurence M. Klauber

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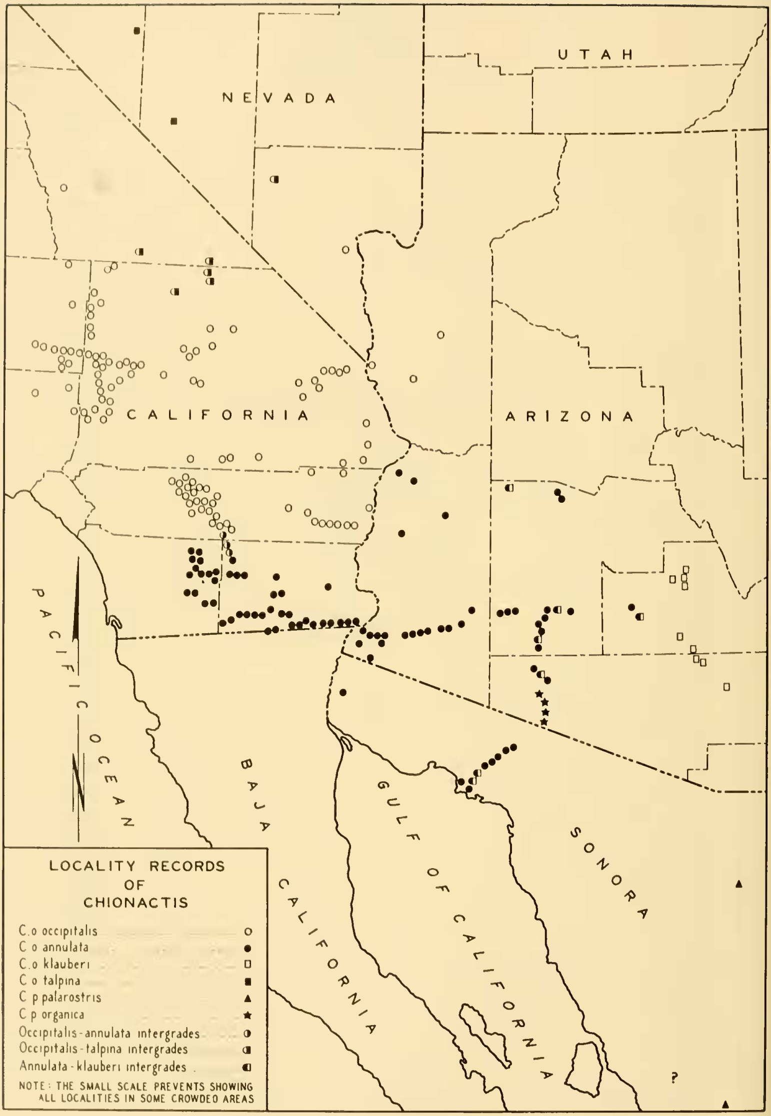
UTAH
NEVADA
CALIFORNIA
ARIZONA
PACIFIC OCEAN
BAJA CALIFORNIA
GULF OF CALIFORNIA
SONORA
?
LOCALITY RECORDS OF CHIONACTIS
C. o occipitalis
C o annulata
C. o klauberi
C o talpina
C p palarostris
C p organica
Occipitalis-annulata intergrades
Occipitalis-talpina intergrades
Annulata-klauberi intergrades
NOTE: THE SMALL SCALE PREVENTS SHOWING ALL LOCALITIES IN SOME CROWDED AREAS

THE SHOVEL-NOSED SNAKE, CHIONACTIS, WITH DESCRIPTIONS OF TWO NEW SUBSPECIES

BY

LAURENCE M. KLAUBER
Curator of Reptiles and Amphibians,
San Diego Society of Natural History

INTRODUCTION

The shovel-nosed snakes of the genus *Chionactis* are small, nocturnal inhabitants of the deserts of the southwestern United States and northwestern Mexico. Like many other desert snakes, they were once thought to be rare, but within the past 20 years it has been found that they are quite common in many places. This discovery has resulted from a new method of collecting, that of driving on paved desert roads at night, when the nocturnal snakes crossing the highway are brightly set off against the dark background of the pavement by the headlights of the car, and may readily be caught. Through this device, the *Chionactis* material in collections has greatly increased in recent years, so that it is now possible to determine subspecific differences with greater assurance than heretofore; and specimens from areas not previously known to be within the range of the genus are at hand.

For some years past, Mr. William H. Stickel has had under way a survey of the snakes of the genus *Sonora.* The shovel-nosed snakes were considered to belong to this genus until Mr. Stickel pointed out differences from *Sonora* warranting their generic separation, and involving the revival for them of the genus *Chionactis* Cope. In the course of his study of *Sonora,* Mr. Stickel made important advances in our knowledge of *Chionactis.* Notwithstanding this work, he courteously agreed to confine his activity to the much more widespread genus *Sonora,* thus permitting me to undertake this study of *Chionactis* without infringing on his program. This generosity on Mr. Stickel's part is much appreciated.

Historical Summary

The first shovel-nosed snake to be classified was collected by A. L. Heermann, the surgeon and naturalist who accompanied Lieut. R. S. Williamson's railroad-route exploring expedition in California in 1853. It was taken in the Mojave Desert, the exact locality being unrecorded. Although the type specimen is no longer available, a drawing of it is at hand (Hallowell, 1859, plate iv, fig. 2). Judging from the narrow crossbars, relative to the width of the interspaces, and the fact that the posterior bars do not cross the ventrum, we may presume it to have come from the western part of the Desert, no doubt from the general area of the Mojave River, in western San Bernardino County, where several other reptiles taken by the expedition are known to have been collected.

The new species was first described by Hallowell in 1854 (p. 95) as *Rhinostoma occipitale.* The genus *Rhinostoma* had been set up by Fitzinger in 1826 (p. 56) with the type species *rufofusca* from Dominica. In 1856, Hallowell decided that the new snake was not congeneric with Fitzinger's *Rhinostoma,* for reasons that he made clear later (1859, p. 16), and therefore he set up the new genus *Lamprosoma* for the shovel-nosed snake (Hallowell, 1856, p. 310). Subsequently, Cope (1860, p. 241) pointed out that the name *Lamprosoma* was preoccupied by a genus of Coleoptera and therefore substituted the name *Chionactis,* "having allusion to the refulgent whiteness of the scales" (*Chion* Gr. snow; *actis* Gr. a ray or beam of light).

Garman (1883, pp. 91, 164) placed the shovel-nosed snakes in the genus *Contia,* but this assignment did not receive wide acceptance. Subsequently, Van Denburgh and Slevin (1913, p. 412) combined them with the ground snakes of the genus *Sonora* and this view was almost universally adopted for the next 30 years.

Finally, Stickel (1943, p. 122) revived *Chionactis,* re-segregating the shovel-nosed snakes from *Sonora* by reason of a number of fundamental character differences, including the nasal valve, a feature of *Chionactis* that he himself had discovered, as well as the angled abdomen, the spadelike snout, fewer maxillary teeth, and hemipenial divergences. To the present writer, Stickel's re-establishment of *Chionactis* appears fully justified.

As has been stated, the first spade-nosed snake was collected in the Mojave Desert in 1853. To this Hallowell (1854, p. 95) assigned the specific name *occipitalis.* The earliest specimens from the Colorado Desert to reach scientific collections were 2 taken by A. Schott, while on the Mexican Boundary Survey in 1855; these became no. 2105* in the collection of the U. S. National Museum (Smithsonian Institution). They may have come from anywhere along the boundary, in what is now Imperial County, California, between the Colorado River on the east and the foot of the coastal mountains to the westward. While Kennicott (in Baird, 1859a, p. 21) considered them to

*Although listed as nos. 2105–6 in the report, both specimens were apparently catalogued under no. 2105.

belong to Hallowell's species *occipitalis*, Baird himself (p. 22) pointed out certain differences, particularly the completeness of the body rings, and assigned them to a new species that he called *Lamprosoma annulatum*. Since then the Colorado Desert form has had a varied career, sometimes being viewed as a subspecies of *occipitalis*, as first suggested by Cope in 1875 (p. 36), but usually being considered synonymous with the Mojave Desert form. Finally, Stickel (1941, p. 135; 1943, p. 122), aided by new material, and making a more thorough study than any previously undertaken, revived *annulata* as a subspecies of *occipitalis*.

Two additional forms have been described recently. In 1937 (p. 363) I named *palarostris* from central Sonora as a full species, although this was subsequently relegated to subspecific status by Stickel (1941, p. 137). Finally, Stickel (1941, p. 138) described the subspecies *C. o. klauberi* from the Tucson area of Arizona. Thus four subspecies of *Chionactis occipitalis* are currently recognized: *occipitalis, annulata, palarostris,* and *klauberi.*

MATERIAL

The present study is based on specimens geographically derived as follows:

San Diego County	345	
Imperial County	58	
Riverside County	126	
San Bernardino County	94	
Kern County	14	
Los Angeles County	2	
Inyo County	3	
Total California		642
Clark County	5	
Nye County	1	
Esmeralda County	2	
Total Nevada		8
Yuma County	45	
Mojave County	2	
Pinal County	10	
Maricopa County	11	
Pima County	27	
Total Arizona		95
Total Sonora		19
Uncertain		6*
Grand Total		770

*Including one doubtfully stated to be from Utah.

Of these specimens, about 60 per cent are contained in my own collection. I have had some field experience with shovel-nosed snakes, and have seen several hundred live specimens.

Character Variation and Sexual Dimorphism

Subspecific differences in *Chionactis* are largely confined to pattern and color, the squamation being relatively constant. Even the pattern is much less variable than in most genera of snakes. There is little doubt that this consistency is related to the circumstance that the ecological range of the genus is one of the most restricted of any snake inhabiting the southwestern United States.

As a preliminary to investigating specific and subspecific differences, I have made it a practice to determine the extent of intrasubspecific variations, using, as a basis of study, the largest available homogeneous population, in this case that from eastern San Diego County, California. This population, as a matter of fact, is not completely homogeneous, since the area inhabited, although including only the desert section of the county, varies somewhat in physiographic character, and likewise in altitude (from 85 to 2300 feet). Also, the population is not pure *annulata*, but shows some *occipitalis* influences. Nevertheless, I have used it in determining degrees of variation and the extent of sexual dimorphism, since this is the only series containing a really adequate number of females. The data on these specimens are as follows:

Number of specimens, males	234
females	106
Coefficients of variation, per cent	
Ventrals, males	2.12
females	2.06
Subcaudals, males	5.38
females	6.23
Body bands, males	9.40
females	10.64
Tail rings, males	12.69
females	13.88
Coefficients of sexual divergence, per cent*	
Ventrals	–5.94
Subcaudals	12.00
Body bands	–9.43
Tail rings	5.23
Correlation coefficient between body bands and tail rings, per cent	42.2

These results are quite consistent with those disclosed in other genera of snakes, for the coefficients of variation of the ventrals in homogeneous series

*Positive if the males are higher, negative if the females are higher.

nearly always adhere closely to 2 per cent, the subcaudals to 5 or 6 per cent, the body bands or blotches to 6 to 10 per cent, and the tail rings or spots to 12 per cent or more.

The sexual differences are all highly significant, but with an order of significance corresponding inversely to their coefficients of variation—that is, the ventral-scale dimorphism is most significant and that of the tail rings least. In the subspecific descriptions and discussions that follow, I shall separate the sexes in presenting the statistics of ventrals and subcaudals, but shall seldom do so in pointing out differences in the number of body bands and tail rings, since sexual dimorphism in these characters is not statistically useful unless many specimens of the two populations to be compared are available, and adequate numbers of females are often lacking. Pattern differences in form and color are, in many cases, as useful as key characters as is the numerical variability in the number of bands across the body.

The scale rows are nearly always 15–15–15, and the ventrals, though showing some territorial variation, involve such inadequate differences as to be of little value in keys. The subcaudals also exhibit some subspecific differences, but these are not extensive, and, as key characters, suffer likewise from the fact that this genus does not possess a conspicuous terminal cone, and hence it is not always possible to determine with certainty whether the tail is complete. Neither the labials nor the other head scales are subject to any subspecific differences, at least none that I have found.

With this uniformity in squamation, taxonomic differentiation is largely reduced to a consideration of pattern, which, fortunately, is subject to much more variation, yet has sufficient constancy in each area to afford valuable differential characters.

Essentially, the *Chionactis* head pattern comprises a dark transverse crescent (black to brown) engaging the parietal region, and thence passing down and forward along the sides until the horns of the crescent terminate in the region of the nostril or the eye. The light ground color of the head is substantially the same as that on the body.

The body pattern involves a series of dorsal crossbands of black to brown, on a light ground color varying from white to cream or yellow. These crossbands may or may not extend to the ventrum to form partial or complete rings. The posterior bands much more often form complete rings than the anterior. The proportion that is complete is an important subspecific criterion. The dorsal bands usually narrow laterally; however, those that cross the belly re-widen ventrally. This is particularly true of the posterior bands.

In most specimens of *Chionactis* the widths of the bands are surprisingly uniform, especially at mid-body and when measured middorsally. One may take a pair of dividers, set it for a single band, and find that it measures accurately the widths of a number of adjacent bands. The same is true of the interspaces.

Bilateral asymmetry in pattern is rare in *Chionactis*, specimens with U- or Y-shaped blotches, such as are highly characteristic of *Hypsiglena* or *Arizona*, being evident in less than 1 per cent of the shovel-noses. I have yet to see a *Chionactis* with non-confluent spots on the two sides, a condition frequently observed in the two genera above mentioned. The middorsal joining of two successive blotches to form dumbbells is likewise rare in *Chionactis*.

Although well defined, the tail rings, which are nearly always complete ventrally, are inferior to the body bands as differential characters for two reasons: First, there is uncertainty as to the completeness of the tail; and, secondly, doubt often exists as to whether the small dark spot that usually terminates the tail should, or should not, be counted as a ring. For this reason, though I have given some tail-ring statistics, I prefer to omit them in deriving key characters. There is seldom a questionable blotch at the base of the tail, which cannot be allocated to the body or tail series, depending on its position with respect to the anal plate.

Although the proportion of dorsal bands that encircle the body is a diagnostic character of value, it is often difficult to tell whether a body ring is, or is not, complete. This is particularly true laterally, where the dark color may be carried only by the scale edges, and observers might differ as to whether the thread-like connecting maculations are, or are not, interrupted. In other specimens these lateral connections are punctated and faint. I have found the presence of a dark mark (however incomplete) on the ventrum opposite the position of a dorsal band, to be a much more objective criterion than the completeness of a ring. Stickel (1941, p. 138) found that *occipitalis* has, on the average, more crossbands than *annulata;* also, that the anterior rings in *occipitalis* are much less likely to be complete ventrally than the corresponding rings of *annulata*. To take advantage of both differences in a single character, he introduced the combination: "Total number of bands (on body and tail) plus the number of body bands not entirely encircling the body." In order to eliminate the uncertainty as to the completeness of the tail, to make incomplete-tailed specimens useful, and to avoid decisions involving doubtfully complete rings, I prefer to substitute the following combination character: "Total number of bands on the body plus the number of unmarked band positions on the ventrum." This criterion sharpens the differences as well as does Stickel's and is more objective in application.

Color is important in the classification of *Chionactis* subspecies, but unfortunately is too evanescent in preserved material to be as fully useful as might be hoped. Three colors are involved: the ground color, the band color, and the color of any suffusion or maculations in the interspaces. The ground color may vary in live specimens from white to various shades of cream, yellow, or buff, but all of these hues usually revert to white or nearly white in preservative.

The black or brown of the bands is also invariably lightened by time and the preservative, particularly if the specimen is not kept in darkness. But, as far as I know, neither black nor brown ever disappears, and thus the shape and arrangement of bands and maculations may always be determined, though the original hues may have changed. It may be noted that in this genus, as in many others, the dark marks are darker and more contrasting with the ground color in juveniles than in adults.

The most important and disappointing changes in the *Chionactis* colors take place in such suffusions as may color the interspaces, particularly their centers. These suffusions, often so definitely outlined that they may be deemed secondary blotches or saddles, may be yellow, orange, vermilion, salmon, or deep red. All of these colors disappear in preservative, the yellows earlier in formalin, and the reds earlier in alcohol, but in either preservative they vanish in time, leaving hardly a trace. A useful criterion is thus lost, even though the specimens have been kept in darkness.

Black or brown interspace maculations constitute another type of markings. These are important, both with respect to their extent and character; they may be dorsal, lateral, or ventral, or all three, and they may engage scale centers, scale edges, or both. As far as I know, these maculations never disappear in preservative, so that one may always know their character, if not their original color, and thus this valuable criterion is in part retained. When the ventrum is spotted, an additional type of marking sometimes present, it is usually not difficult to recognize the first blotch that is the ventral analogue of a dorsal band, this blotch being independent of the general spotting.

Dorsal bands are usually of solid color and even-edged. However, in the snakes from some areas the dark part of any scale that is half, or less than half, dark is lighter than the adjacent, completely dark scales. The blotch edge is thus given a serrated appearance. In some specimens the dark color of a band is carried beyond the normal edge of the band along the interstices between scales.

In determining the relative widths of dorsal bands and interspaces, I have usually employed a draftsman's bow dividers, measuring a sample series of 3 or 4 bands at mid-body. Counting scales end-to-end may also be useful, particularly if adults are to be compared with juveniles.

It will sometimes be found of interest to study the position and extent of the head crescent, particularly its forward edge with relation to the supraoculars and frontal, and whether posteriorly it extends beyond the parietals, or does not completely cover them. There is also some difference in the extent of the horns of the crescent, which in some subspecies terminate at the eye, but in others reach as far forward as the nasal scales. Another character sometimes useful is the number of light scales (end-to-end) between the posterior edge of the head crescent and the anterior edge of the first body band.

GENUS *CHIONACTIS*

Lamprosoma Hallowell, Proc. Acad. Nat. Sci. Phila., vol. 8, p. 310, Dec. 1856. Type species *occipitale.*

Chionactis Cope, Proc. Acad. Nat. Sci. Phila., vol. 12, p. 241, June 1860. Type species *occipitale.*

The snakes of this colubrid genus are small and of moderate body proportions. The maximum length attained in any area is somewhat over 400 mm. (15¾ in.). The head is only slightly distinct. The pupil of the eye is round. The tail length varies from 19 to 22 per cent of the length over-all in the adult males, and from 15 to 19 per cent in the females. The snout is quite sharp, with a horizontal cutting edge to facilitate progress through sand; other modifications favorable to an arenaceous existence are the presence of a nasal valve, and a protrusion at the tip of the mental plate which serves to close the apperture through which the tongue is thrust out. There is a sharp angle, represented by a bend in the ventrals, between the abdominal crawling surface and the sides of the body.

The rostral is sharply recurved and pointed posteriorly, but does not separate the internasals. It is somewhat raised above the adjacent plates and is deeply cleft on the under side. The plates on the crown follow the usual colubrid pattern. The parietals are the largest of the head plates, followed by the frontal. The nostril is placed in an undivided nasal, usually slightly forward and above its center. A small loreal, longer than high, is usually present; it is widest anteriorly. There is ordinarily a single preocular and 2 postoculars, of which the upper is the larger. The temporals are usually 1 followed by 2. The upper labials almost always number 7, the next to the last being the largest; the third and fourth touch the eye. The lower jaw is deeply inset. The lower labials usually number 7; the fourth is the largest. The quadrangular mental has an anterior protuberance that is centrally ridged, with a depression on either side. The anterior genials meet on the median line; the posterior, much reduced in size, are separated by gular scales.

The dorsal scales are smooth and rarely in other than 15–15–15 rows. Single apical scale pits are faintly evident on some scales, particularly on the sides of the body. The ventrals vary from 141 to 165 in the males, and 153 to 178 in the females. The anal is divided. The subcaudals range from 39 to 57 in the males, and 34 to 51 in the females. Normally all subcaudals are divided.

The pattern comprises a series of black or brown crossbands on a white to yellow ground color. These bands vary from 10 to 40 on the body and from 3 to 13 on the tail. The bands narrow laterally; some completely encircle the body, widening again on the ventrum. A characteristic black or brown crescent on the head usually engages the parietals, with the horns carried forward on the sides to the eyes or even to the nostrils. The dorsal bands may be either wider or narrower than the interspaces. The interspaces may be marked dorsally in various ways, either suffused with pink or red, or maculated with black or brown, so that in some specimens the secondary blotches or saddles are almost as definite as the primary. The ventrum is sometimes spotted, in addition to being marked by such bands as may be carried to the under surface.

There are 3 maxillary foramina and the maxillary teeth number 8+3 or 9+3 (Stickel). The hemipenis has a distal section of fine and almost uniform reticulations or flounces. The outermost part comprises two low mounds, otherwise the organ is undivided. The basal spinous section contains 2 large spines, one on each side of the sulcus, and about 30 much smaller spines. The transition from reticulations to spines is quite sharp. The sulcus passes diagonally from the spinous base across the reticulations to the top of one of the terminal mounds. It ends among the reticulations, there being no smooth area.

In the southwest, *Chionactis* is most often confused with *Chilomeniscus*, or with some of the crossbanded subspecies of *Sonora*. The separation from the first-named is simple, for in *Chilomeniscus* the nasals are merged with the internasals, whereas in *Chionactis* they are not. *Chilomeniscus* almost invariably has 13 scale rows and *Chionactis* 15. From *Sonora, Chionactis* differs in having a flatter snout, an angled abdomen, nasal valves, a protrusion on the mental, and a proportionately shorter tail. The bands on *Sonora* are less definitely outlined. In practice I have found that these characters serve readily to segregate *Chionactis* from banded forms of *Sonora*—some subspecies of *Sonora* are striped or unicolor—except when the specimens are badly preserved or dried juveniles.

SPECIES AND SUBSPECIES DESCRIPTIONS

Chionactis occipitalis occipitalis (Hallowell)

MOJAVE DESERT SHOVEL-NOSED SNAKE

Plate 9, fig. 1

1854. *Rhinostoma occipitale* Hallowell, Proc. Acad. Nat. Sci. Phila., vol. 7, p. 95. Type specimen unknown (figured in Hallowell, 1859, plate 4, figs. 2a, 2b, 2c); type locality Mohave Desert.

1856. *Lamprosoma occipitale* Hallowell, Proc. Acad. Nat. Sci. Phila., vol. 8, p. 311.

1859. *Lamprosoma occipitale* (part) Baird, Gen. Rept. Zoöl. Pac. R.R. Routes, vol. 10, part 3, p. 16.

1860. *Chionactis occipitalis* Cope, Proc. Acad. Nat. Sci. Phila., vol. 12, p. 241.

1870. *Chionactis occipitalis* (part) Cooper, Proc. Calif. Acad. Sci., vol. 4, part 2, p. 66.

1875. *Chionactis occipitalis occipitalis* Cope, Bull. U. S. Nat. Mus., no. 1, p. 35.

1883. *Contia occipitalis* var. *occipitalis* Garman, Mem. Mus. Comp. Zoöl., vol. 8, no. 3, pp. 91, 164.

1894. *Contia occipitalis* (part) Boulenger, Cat. Snakes Brit. Mus., vol. 2, p. 266.

1901. *Contia occipitale* (part) Brown, Proc. Acad. Nat. Sci. Phila., vol. 53, part 1, p. 68.

1916. *Sonora occipitalis* Camp, Univ. Calif. Pubs. in Zoöl., vol. 12, no. 17, pp. 503-544.

1917. *Sonora occipitalis* (part) Grinnell and Camp, Univ. Calif. Pubs. in Zoöl., vol. 17, no. 10, p. 182.

1941. *Sonora occipitalis occipitalis* Stickel, Bull. Chicago Acad. Sci., vol. 6, no. 7, p. 135.

Diagnosis.—A subspecies of *occipitalis* differing from the subspecies of *palarostris* in having more crossbands on the body and tail. It is distinguishable from the other *occipitalis* subspecies as follows: from *klauberi* and *talpina* in usually lacking dark maculations in the interspaces between the primary bands or, at least, in having such spots as may exist in these spaces generally small, scattered, and restricted to scale edges; and from *annulata* in having brown, rather than black, or nearly black, crossbands, and in having more crossbands, fewer of which, however, are carried to the ventrum anteriorly.

Nomenclatorial and Systematic Problems.—The type locality of this subspecies is not known definitely, having been recorded only as the "Mohave Desert" (Hallowell, 1854, p. 95). Whether the type specimen is still in existence is not known; fortunately, it was figured by Hallowell rather completely in a later paper (1859, plate 4, figs. 2a–2c). One may hazard the guess, based on the known itinerary of the collecting expedition and the character of the crossbands—their narrowness and their failure to cross the ventrum—that it probably came from the western Mojave, in the general vicinity of the Mojave River in the southwestern part of what is now San Bernardino County, California.

The most interesting problem with respect to the distribution and variations in this subspecies is the unusual relationship between the populations of the Colorado and Mojave deserts. In most reptile species, if a difference is evident between such populations, the Coachella Valley (Riverside County) population is found to belong to the southern (Colorado Desert), rather than to the northern (Mojave Desert), form, as would be expected, for the Coachella Valley is a northwesterly extension of the Colorado Desert. Of such a territorial pattern, the separation of the Mojave Desert forms *Pituophis catenifer deserticola* and *Crotalus cerastes cerastes* from the corresponding Colorado Desert *P. c. affinis* and *C. c. laterorepens* are examples. In both instances the Coachella Valley inhabitants belong to the southern race. But in *Chionactis,* the Mojave Desert form occupies the Coachella Valley and the eastern part of Riverside County as well. Under such circumstances one should expect at least some differences between the Mojave and Coachella populations, and I had hoped to find a character that might separate the two and thus interpose an additional subspecies between *occipitalis* and *annulata.* Average differences have been disclosed, but the overlaps are such that segregation does not seem advisable, at least there is no justification on the basis of any character that I have been able to discover. Such differences as there are will be discussed later.

Material.—The description of the subspecies *occipitalis* that follows is based on about 240 specimens; however, there is far from an adequate representation of all areas, since much more than half the material is from two sections, the western Mojave Desert and the Coachella Valley. The eastern and extreme southeastern sections of the range are poorly represented in collections.

Description of the Subspecies.—This widespread subspecies, which inhabits more than half of the total area assigned to the species *occipitalis* as a whole, is quite variable in pattern, but much less so in squamation.

The largest specimens that I have seen were 369 mm. (14½ in.) long; I have had both a male and female of this length. In the western Mojave, males 320 mm. (12½ in.) long are not uncommon; in the Coachella Valley they frequently reach 340 mm. (13½ in.). Having in mind the fact that the males in collections usually outnumber the females by 2 to 1 or more, I should say that there is no conspicuous difference between the sexes in the ultimate length attained. The shortest juveniles seen were Mojave specimens 121 and 122 mm. (4¾ in.) long. The ratio of the tail length to the length over-all in adult males ranges from 17 to 20 per cent, with a mean of 18.5 per cent; and in the adult females from 15.5 to 17.5 per cent, with a mean of 16.7 per cent. Juveniles have somewhat shorter tails, proportionately, than adults.

The scale rows number 15 at mid-body, with only one exception among all the specimens of this subspecies that I have examined. The aberrant specimen was one from the Coachella Valley having 14 rows. There are frequently 17 rows on the neck, but they are reduced to 15 at or near one head-length behind the head. Similarly, when there are, rarely, 13 rows just before the anal plate, this number persists for only a short distance.

The ventrals range from 146 to 165 in the males, mean 155.9; and from 154 to 176 in the females, mean 165.9. The subcaudals vary from 39 to 50* in the males, mean 44.7; and 37 to 48 in the females, mean 41.9. Occasionally a few subcaudals at the base of the tail are undivided.

The supralabials are normally 7–7, less than 2 per cent having 6. The third and fourth touch the orbit and the sixth is the largest. The infralabials are usually 7 on each side, but occasionally number 6 or 8. Because of the position of the last infralabials, it is sometimes difficult to decide whether or not the last scale should be included.

There is usually a single loreal on each side; however, about 5 per cent of the specimens have one or both loreals fused with the prefrontals, and one specimen has 2 loreals on one side. The preoculars are rarely divided (about ½ of 1 per cent), and a very few specimens have single or 3 postoculars, instead of the customary 2. The usual temporal formula is 1+2, but some specimens (about 2 per cent) have 1+1, and still fewer have 1+3 or 2+2.

The crossbands on the body vary from 25 to 40, mean 31.2; and on the tail from 6 to 13, mean 9.2. The bands may be wider than, equal to, or narrower than the interspaces; there is some territorial variation in this character, as is discussed below. Spotting in the interspaces is rather infrequent; when present it usually takes the form of dark edges on some of the lateral scales. Ventral spotting between the positions opposite the dorsal bands is unusual but occasionally noted.

This subspecies is characterized by the relative infrequency with which the anterior dorsal crossbands become complete rings, or involve correspondingly located dark blotches on the ventrum. The contrary is true in *annulata*. As *annulata* also has fewer bands than *occipitalis*, the combination criterion, dorsal bands plus unmarked blotch positions on the ventrum, serves as the best

*Omitting two aberrants with 35 and 54, respectively.

numerical character in differentiating the subspecies. The statistics of *occipitalis* with respect to this character are: range 31 to 80, mean 54.7. About 20 per cent of the specimens number 44 or fewer, and thus fall within what may be considered the *annulata* range (p. 164).

Essentially, *occipitalis* is a snake with brown crossbands on a white or cream ground color, at least, this is the appearance of preserved specimens. The band color may vary from medium- to dark-brown. Rarely does it give the impression of being black, except in juveniles. Dorsally the bands do not differ greatly from the interspaces in width—they may be either somewhat wider or narrower. Laterally the bands narrow conspicuously, usually to terminate on the first or second row of scales above the ventrals. Even posteriorly, where they are often complete, the rings narrow laterally, although they may re-widen on the ventrum. The band color is darker dorsally than that it is below. The blotches are often even-edged, but in many specimens thin threads of the dark color of the blotches run out into the interspaces along the interstices between scales. Also, on the edges of the bands, scales that are partly light and partly dark often are not as dark in their dark section as are the adjacent scales that are entirely dark, thus giving an effect of serrations. In such partly dark scales the dark color consists of punctations.

The head crescent usually engages only the posterior halves of the frontal and supraoculars. The lateral horns are not often carried farther forward than the eye.

Regardless of whether the ventrum is marked on the body, the tail bands are nearly always complete rings. The anal, however, is rarely marked, even though there may be a dorsal band immediately above it.

As to live specimens, the following Ridgway colors are typical of adults from the western Mojave Desert and from the Coachella Valley:

	Western Mojave Desert	*Coachella Valley*
Snout	Sea-foam Green	Olive Buff
Head crescent	Blackish Brown (1)*	Bone Brown
Dorsal bands	Aniline Black	Bone Brown
Interspace centers	Ochraceous-Buff	Pale Chalcedony Yellow
Interspace edges	Marguerite Yellow	White
Ventral bands	Light Seal Brown	Natal Brown
Ventral interspaces	Ivory Yellow	Pale Olive Buff

The snout is usually darker and slightly greener than the interspaces on the body. The ventral surfaces are somewhat lighter than the dorsal, a characteristic of both the bands and the interspaces.

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*The numeral is a part of the color name, as Ridgway distinguishes between 3 tones of blackish brown.

In general, these live snakes may be described as having brown crossbands on a yellow or orange ground color.

Intrasubspecific Trends.—Of the subspecies *occipitalis* only two series that are territorially concentrated are available in sufficient numbers to justify numerical comparisons. These are a Coachella Valley series from Riverside County, and a series from the western Mojave Desert, within a radius of about 40 miles of Kramer Junction, San Bernardino County. The first series comprises 100 specimens, the second 65; males greatly predominate in both. The statistics follow:

	Western Mojave Desert series	*Coachella Valley series*
Ventrals, males, range	148–162	151–165
mean	155.3	156.8
females, range	159–169	160–176
mean	163.0	167.4
Subcaudals, males, range	40–49	41–49
mean	44.3	44.7
females, range	37–43	39–48
mean	41.0	42.2
Crossbands on body, range	24–39	25–40
mean	29.8	32.2
Crossbands on tail, range	6–11	6–12
mean	8.7	9.5
Crossbands on body plus unmarked ventral positions, range	37–78	31–76
mean	57.6	59.0
Per cent of specimens with no ventral blotches on body	39.5	29.3

It will be observed that the numerical differences between these series are relatively minor. Only in the percentage of snakes without blotches on the ventrum is there a distinct difference, the Mojave series being less maculated. The same is true if we take the proportion of the dorsal band positions that have opposite marks on the ventrum. In the Coachella series, of those with some ventral marks, specimens having from 40 to 70 per cent of the ventrum clear approximately equal in frequency those having 70 to 99 per cent clear. But in the Mojave series nearly all fall in the 70 to 99 per cent class, and very few below. Thus, in these characters indicating the relative absence of ventral maculations, the Mojave specimens are clearer and more sharply differentiated from *annulata* than are those of the Coachella Valley.

As to colors, the most important, from the standpoint of general appearance, are obviously those of the dorsal bands and the centers of the interspaces. The following Ridgway colors were noted in 20 live specimens from the western Mojave Desert and 12 from the Coachella Valley:

Dorsal Crossbands

Western Mojave Desert	*Coachella Valley*
Natal Brown	Light Seal Brown
Blackish Brown (1)*	Seal Brown
Blackish Brown (3)*	Hay's Brown
Sooty Black	Bone Brown
Chaetura Black	Dusky Brown
Plumbeus Black	Warm Sepia
Fuscous Black	Blackish Brown (2)*
	Warm Blackish Brown
	Aniline Black
	Black

Centers of Interspaces

Chamois	White
Colonial Buff	Deep Colonial Buff
Salmon Buff	Cinnamon Buff
Warm Buff	Buff Yellow
Apricot Yellow	Sea-foam Yellow
Reed Yellow	Pale Chalcedony Yellow
Honey Yellow	Primrose Yellow
Naples Yellow	
Straw Yellow	
Salmon Orange	
Ochraceous Orange	
Capucine Orange	
Vinaceous Cinnamon	
Ochraceous Salmon	

It will be observed that there is not much difference in the depth of the browns and dark-browns of the bands, but the interspaces are a brighter yellow in the Mojave snakes, with more of a tendency toward orange.

The dark bands, middorsally, are narrower than the interspaces more frequently in the Mojave specimens than in those from the Coachella Valley, for, in the latter, the dark bands are wider than, or equal to, the interspaces more often than narrower. There is no conspicuous difference in the number of uncolored dorsal scales between the head crescent and the first dark band on the body; in both series the range is from 3 to 6, many specimens having 4. In both series the head crescent usually extends to the posterior edge of the parietals, or slightly beyond; and, in both, the lower preoculars are ordinarily darkened by the horns of the crescent. Dark scale edges in the lateral inter-

*Different colors in Ridgway's notation.

spaces are of moderate frequency in both series; and in each an occasional specimen is found showing considerable interspace maculations, a *klauberi* or *talpina* tendency. A single specimen from an altitude of 3000 ft. on the Palms-to-Pines highway, above the Coachella Valley, has particularly wide dark bands.

There is no marked difference between the Mojave and Coachella series in the relative tail lengths. Both have shorter tails than *annulata.*

The absence of important differences between the western Mojave and Coachella groups is the more surprising in view of the differences in their surroundings. The Coachella is a flatter, sandier basin, much of it below sea level. The western Mojave is rockier; the mean altitude of the section from which the example series came is about 2200 ft. It has a longer, colder winter. Both areas are extremely windy at night in the spring. It is to be presumed that *occipitalis* gained access to the Coachella Valley from the Mojave via the Morongo Valley to the north, or via the pass between the Cottonwood and Orocopia mountains to the east. Since the western Mojave and Coachella snakes more nearly resemble each other, in their lack of ventral maculations, than either resembles the snakes farther east, the Morongo route appears the more logical.

One may presume that the differences between the Colorado Desert *annulata* and Mojave Desert *occipitalis* are either not importantly fitted to ecological necessities, or that the invasion of the Coachella Valley by *occipitalis* has been comparatively recent. I judge the former to be the real reason why the Coachella snakes are not more like the snakes of the lower Colorado Desert, although I do think that the meeting of *occipitalis* and *annulata* along the westerly shore of the ancient Lake LeConte took place rather recently, possibly at the time of its latest subsidence.

Specimens from the vicinity of Boulder City, Clark County, Nevada, and from eastern San Bernardino and Riverside counties in California, are not available in sufficient numbers to permit a detailed analysis of territorial trends. They average slightly lower in the number of body bands, and the ventrums are more maculated—that is, the ventral blotches begin nearer the head, and fewer specimens are without at least some ventral marks on the body. In this character they show a tendency toward *annulata.* In the Clark County specimens, the dorsal bands are wider than the interspaces, whereas the contrary is true in those from the western Mojave.

It may be concluded that the population of *occipitalis* most widely differentiated from *annulata,* as well as from *talpina, klauberi,* and *palarostris,* is that inhabiting the extreme western section of the range, that is, the Mojave-Kramer-Adelanto-Palmdale quadrangle in the western part of the Mojave Desert. Geographically this is quite logical.

Subspecific Relationships.—*C. o. occipitalis* intergrades with two other subspecies, *talpina* and *annulata,* and possibly with a third, *klauberi.*

With the new subspecies *talpina,* it intergrades along the southern border of eastern Inyo County, California, and near the eastern edge of Nye County, Nevada, as will be discussed in more detail under *talpina.*

Although many specimens of the subspecies *occipitalis* and *annulata* are at hand, and the fact that they intergrade is unquestioned, the boundaries between their ranges cannot be defined with assurance, partly because of lack of specimens from critical areas, and partly because of the composite character of the material from eastern San Diego County. Pure *occipitalis* occurs in the Coachella Valley of Riverside County, and pure *annulata* in the Kane Spring–Westmorland section of Imperial County. The two subspecies apparently intergrade in the neighborhood of Travertine Rock and Fish Springs in extreme northwestern Imperial County. This is logical, especially if we assume that the two populations were originally separated by prehistoric Lake LeConte, which once filled what is now the Salton Basin, and that they re-merged when the lake dwindled to leave a flat margin between its western shore and the mountains. However, the snakes of eastern San Diego County are not pure *annulata*, as one might expect, but show a considerable infusion of *occipitalis* characters. Whether this has resulted from a southward migration of *occipitalis* around the lower end of the Santa Rosa Mountains into the Borrego Valley, or whether these characters were developed independently in the San Diego population because of its desert-mountain habitat is uncertain.

For the present, I shall consider the San Diego County population to be *annulata*, but of a non-typical character, and the western end of *occipitalis–annulata* line of intergradation to be near Travertine Rock, at the Imperial–Riverside county line. Eastward of the Salton Sea, we may assume the boundary to follow the crest of the Chocolate Mountains southeasterly to the Colorado River. Across the river, in Arizona, the dividing line may be tentatively placed at the Bill Williams River. Of the few specimens available from this section of Arizona, those from the vicinity of Parker and farther south in Yuma County are nearer *annulata*, while the only two from Mohave County favor *occipitalis*.

The only two specimens now at hand from northern Maricopa County are *annulata* or *annulata–klauberi*, rather than *occipitalis–klauberi* intergrdes. But it is not impossible that *occipitalis* and *klauberi* may intergrade somewhere along the line Yucca–Alamo–Wickenburg, if *Chionactis* occurs, as it may, in that relatively inaccessible region, in which there has been little or no collecting.

Range.—*Chionactis o. occipitalis* is found throughout the Mojave Desert of southwestern Inyo County, eastern Kern County, northeastern Los Angeles County, San Bernardino County (except the mountain and transmontane area in the southwest), Riverside County (from the desert slope of the San Jacinto Mountains eastward, including the Coachella Valley), and northeastern Imperial County (beyond the Chocolate Mountains), California; southern Clark County, Nevada; and southwestern Mohave County, Arizona.

Locality Records.—CALIFORNIA: *Inyo County*—Owens Lake, Goler Canyon (Panamint Mts.) (*talpina* intergrade), 11 mi. s. of Shoshone (*talpina* intergrade); *Kern County*—Brown, Garlock, Mojave (also 4, 6, 11, 17 mi. e.), Muroc (also 4 mi. se.), Muroc Dry Lake, Boron (also 1, 11, 12 mi. w.); *Los Angeles County*—20 mi. e. of Lancaster, 3 mi. n. of Palmdale, county line e. of Llano (about 9 mi. e.); *San Bernardino County*—Trona (also 2 mi. n.), 10 mi. s. of Salt Wells Jnct. (=5 mi. n. of Searles Sta.), Lava Mts., Red Mt. (also 13 mi. s.), Atolia (also 3 mi. n. and 11 mi. s.), Fremont (=14 mi. n. of Kramer Jnct.), Kramer (also 1 mi. w.), Kramer Jnct. (U.S. 395 and U.S. 466) (also 1 mi. w. and 1, 3, 4, 6, 11, 12, 13, 14 mi. s.) Kramer Hills, Adelanto (also 1, 3, 5, 6, 7, 8, 9, 10, 12, 13, 14, 16, 17 mi. n., 7 mi. sw., and 11 mi. s.), Oro Grande (also 12 mi. n. = 1 mi. s. of Helendale), Victorville (also 3 mi. s.), Phelan (also 5 and 6 mi. nw.), 16 and 22 mi. s. of Shoshone (Inyo Co.) (= Ibex Pass and 7 mi. s.) (*talpina* intergrades), 1 mi. e. of Leach Lake (*talpina* intergrade), 16 mi. e. of Camp Irwin (near Red Pass Dry Lake), Baker, Midway (also 4 mi. e. on U.S. 91), Cronise, Alvord Mts., Jim Grey, Hawes, Hinkley (also 2 mi. w.), Mace, Lenwood, Barstow (also 2, 6, mi. w., and 15 mi. sw.), Minneola, Hector, 2 mi. n. of Mt. Pisgah Crater, Arimo, Fenner (also 10 mi. w.), Goffs (also 5 and 12 mi. e.), Homer, Piute Valley, 25 mi. s. of Needles on Cal. 95, 8 mi. n. of Rose (= Vidal Jnct.), ½ way bet. Rose and Grommet, Rice (= Blythe Jnct.) (also 1 mi. s.), Warren Wells (= Lone Star), Twentynine Palms (also 3 mi. w. and 19 mi. e.), Monroe Dry Lake (not located); *Riverside County*—Desert Hot Springs (also 3 mi. s.), near Seven Palms, Garnet (also 4 mi. n. and 5 mi. se.), Whitewater (also 3 and 5 mi. se.), Palm Springs R.R. Sta., Palm Springs (also 4, 5, 10 mi. n., 7 mi. nw., 4 mi. e., and 10 mi. se.), Palm Springs Airport, Tahquitz Canyon, Rimlon, Thousand Palms P.O. (also 5 mi. n. and 6 mi. w.), Thousand Palms, Edom, Cathedral City (also 1 mi. e. and 2 mi. s.), Date Gardens, Palm Village (also 3 mi. e.), Palms-to-Pines Highway (Cal. 74) just above 3000 ft. contour, also 2 mi. s. of Palm Village, Indian Wells (also 2 and 3 mi. e.), sand dunes 5 mi. n. of Indian Wells, Myoma, La Quinta (also 2 mi. e.), Indio (also 2, 4, mi. n., 3 mi. e., 6 mi. s., 5, 7, 10, 11, 16 mi. nw., and 5 mi. w.), Pushawalla and Berdoo canyons (Little San Bernardino Mts.), Coachella (also 5 and 6 mi. s.), Thermal, Mecca (also 2 mi. e. and 3 mi. sw.), 10 mi. n. of Riverside-San Diego county line (= Martinez), Caleb Siding, Oasis (also 7 mi. nw.), 1 mi. nw. of Travertine Rock (*annulata* intergrade), 15 mi. w. of Freda (San Bernardino County), Desert Center (also 11 and 16 mi. e.), Hopkins Well (also 2 mi. w. and 7 mi. e.), 6, 7, 10, 12, 16, 17, and 22 mi. w. of Blythe, 10 mi. n. of Blythe, Camp (= Dry Camp Siding?), Banning*; *Imperial County*—Travertine Rock (*annulata* intergrade), Fish Springs (*annulata* intergrade).

NEVADA: *Clark County*—near Indian Spring (*talpina* intergrade), Boulder City.

ARIZONA: *Mohave County*—Fort Mohave, Yucca, Hualpai Valley.

Chionactis occipitalis annulata (Baird)

COLORADO DESERT SHOVEL-NOSED SNAKE

Plate 9, fig. 2

1859. *Lamprosoma occipitale* Kennicott in Baird, Reptiles of the Boundary, United States and Mexican Boundary Survey (Emory), vol. 2, p. 21.

*An MCZ specimen; this locality should be considered doubtful until verified by additional specimens.

1859. *Lamprosoma annulatum* Baird, Reptiles of the Boundary, United States and Mexican Boundary Survey (Emory), vol. 2, p. 22, plate 21. Type specimens (2) USNM 2105*; type locality Colorado Desert.

1859. *Lamprosoma occipitale* (part) Baird, Gen. Rept. Zoöl. Pac. R.R. Routes, vol. 10, part 3, p. 16.

1870. *Chionactis occipitalis* (part) Cooper, Proc. Calif. Acad. Sci., vol. 4, part 2, p. 66.

1875. *Chionactis occipitalis annulata* Cope, Bull. U. S. Nat. Mus., no. 1, p. 36.

1883. *Contia occipitalis* var. *annulata* Garman, Mem. Mus. Comp. Zoöl., vol. 8, no. 3, pp. 91, 164.

1894. *Contia occipitalis* (part) Boulenger, Cat. Snakes Brit. Mus., vol. 2, p. 266.

1901. *Contia occipitale* (part) Brown, Proc. Acad. Nat. Sci. Phila., vol. 53, part 1, p. 68.

1913. *Sonora occipitalis* Van Denburgh and Slevin, Proc. Calif. Acad. Sci., ser. 4, vol. 3, p. 412.

1917. *Sonora occipitalis* (part) Grinnell and Camp, Univ. Calif. Pubs. in Zoöl., vol. 17, no. 10, p. 182.

1941. *Sonora occipitalis annulata* Stickel, Bull. Chicago Acad. Sci., vol. 6, no. 7, p. 136.

1943. *Chionactis occipitalis annulatus* Stickel, Proc. Biol. Soc. Wash., vol. 56, p. 128 [= 123].

Diagnosis.—*C. o. annulata* is a subspecies differing from *klauberi* and *talpina* in usually lacking maculations in the interspaces between the primary dorsal bands; such spotting as there may be is usually restricted to the sides of the body and to scale edges. From the subspecies *occipitalis*, *annulata* differs in having black, rather than brown, dorsal bands, and also in having a greater proportion of anterior bands carried to the ventrum. *C. o. annulata* has more crossbands and a sharper snout than the subspecies of *C. palarostris*.

Nomenclatorial and Systematic Problems.—The type locality of *annulata* was generalized as the "Colorado Desert", but it may be inferred, both from the itinerary of the collector and from the morphology of the types, that they were collected somewhere along the U.S.–Mexican boundary between the Colorado River on the east and the desert base of the coastal mountains on the west, along what is now the southern border of Imperial County, California.

The important problems of this subspecies concern not only its relationships with *palarostris*, *klauberi*, and *occipitalis*, but also the variations, within the subspecies, between the snakes from the east and west sides of the Colorado River, that is, between those from the Yuma and the Colorado deserts. Another

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*Although the original description in the Mexican Boundary Survey report lists two specimens as numbers 2105–6, I am advised by Dr. Doris M. Cochran that it is doubtful whether there ever was a number 2106, since both types were included under the number 2105.

problem is to consider whether the differences between the snakes inhabiting the flat expanses of the Colorado Desert and those from the desert foothills of the San Diego mountains seem to have been caused by ecological differences, or by an infusion of *occipitalis* around the southern end of the Santa Rosa Mountains into the Borrego Valley and beyond.

Material.—The data on this subspecies are derived from somewhat more than 400 specimens from California, 50 from Arizona, and 18 from Sonora. Unfortunately, a large part of the California material is from San Diego County, where the population does not represent pure and typical *annulata.*

Description of the Subspecies.—Like the other *occipitalis* subspecies, this is a snake of rather constant scale characters, but with observable intrasubspecific differences in pattern and color, some of which differences are territorially consistent.

The longest specimen thus far accurately measured is a female 407 mm. (16 in.) in length over-all.* The shortest is 130 mm. (5⅛ in.); two others are 132 mm. In Imperial County, where the genus seems to attain its maximum length, the females grow slightly larger than the males; females of 370 mm. (14½ in.) are not exceptional, whereas the longer males average only 350 mm. (13¾ in.).

The tail length in the adult males varies from 17.9 to 20.2 per cent of the length over-all, with a mode of 19.7 per cent. In the adult females, the range is from 15.7 to 18.4 per cent, with a mode of 17.0. The juveniles have proportionately shorter tails, the mode for the young males being 18.2 and for the females 15.0 per cent. In the San Diego County material, the regressions are fairly well represented by the following straight lines, in which T is the tail length and L the length over-all, both expressed in millimeters: males, $T = .207\,L - 3.35$; females $T = .185\,L - 5.00$. The snakes of the Imperial-Yuma area have slightly longer tails, proportionately, than those from San Diego County.

The scale rows are almost always 15 at mid-body; among more than 400 specimens, two have 16, and one has 14. There may be 17 or 16 for a short distance behind the head, and 14 or 13 just before the anus, but almost all specimens are 15–15–15 according to the usual method of scale-row expression.

The ventrals in the males vary from 143 to 164, mean 153.2; and in the females from 153 to 178, mean 163.5. The subcaudals vary from 40 to 57, with a mean of 47.4 in the males; and from 34 to 51, mean 42.4 in the females. These averages for the subspecies as a whole are somewhat reduced by the high proportion of San Diego County specimens.

The supralabials nearly always number 7, about one per cent having 6, and still fewer 8. As in the other subspecies, the third and fourth enter the orbit, the sixth being the largest. The infralabials also generally number 7, although a count of 8 on either or both sides is not unusual, and a few have 6.

*I have a record of a live specimen about 425 mm. (16¾ in.).

It is often difficult to count the infralabials accurately, since the posterior termination is not definite.

In most specimens there is a single loreal on each side, but about 10 per cent are without loreals, these scales being fused to the prefrontals. Two loreals per side are rare. Although a single preocular is normal, 1 per cent of the specimens have 2. One postocular, instead of the normal 2, occurs in about 1 per cent; 3 on a side are rarely observed. The usual temporal formula is 1+2; some 3 per cent of the counts are 1+1, about 1 per cent 2+2, and still fewer 1+3.

The dark crossbands on the body vary from 18 to 35, with a mean of 24.9; and the tail rings from 5 to 12, mean 7.7. The bands in this subspecies may be either narrower or wider than the interspaces, but in most specimens the bands are the narrower. There may be some spotting in the interspaces, on the sides especially; this spotting is usually restricted to darkened scale edges, and becomes somewhat more frequent as the *klauberi* territory is approached. There is also occasionally present a type of ventral spotting that is independent of the body rings.

The subspecies *annulata* differs from *occipitalis* in the greater frequency with which the dark dorsal bands become complete rings by crossing the ventrum. In both subspecies the anterior bands are less often complete than the posterior, but in *annulata* the ventral blotches that complete the rings make their appearance nearer the head than in *occipitalis*. For reasons discussed elsewhere, I prefer to use, in differentiating the subspecies, the following combination criterion: the dorsal bands plus the anterior unmarked blotch positions on the ventrum, counting up to the first apparent ventral blotch. Only about 20 per cent of the specimens of *occipitalis* fall below 45 in this criterion, while in *annulata* only 9.6 per cent have 45 or more. In *annulata* the range is 22 to 59 and the mean 35.1. These values are rendered somewhat higher, both in range and average, because of the higher proportion of San Diego County specimens, which deviate from the subspecific mode (see below).

Superficially, preserved specimens of *annulata* are black-ringed snakes with a white or cream ground color. Actually, if one compares the bands of fresh specimens with the darkest colors of the Ridgway series, it will be found that they are seldom truly black; and they fade to a still lighter color on exposure to light. But on a casual examination, without comparative color guides, the rings in well-preserved material appear black. Many live specimens have varying degrees of pink or red suffusions in the interspaces, and some of these colors may be retained for a time after preservation.

The body bands may be even-edged or somewhat serrated. Anteriorly they usually end at the first to third scale row above the ventrals, their terminations being rather blunt; then, as one proceeds posteriorly, it will be observed that the bands become more pointed laterally, as if reaching out to contact the ventral blotches which correspondingly rise higher on the sides. Finally, the dorsal and ventral sections of the bands become confluent and the rings are complete, usually on the anterior quarter of the body. But since the first lateral contacts between the dorsal and ventral bands are rather tenuous, it is difficult to decide which ring is to be counted as the first complete one. It is for this reason that I prefer to use the first ventral spot in the differential criterion, rather than the first complete ring.

The ventral marks are lighter than the dorsal. Posteriorly the ventral blotches widen considerably, sometimes darkening as many as 4 adjacent ventral scutes.

The black head crescent is rather narrow in this subspecies. Often the frontal remains unmarked, and the supraoculars are darkened only along their outer edges. Posteriorly the tips of the parietals may remain unmarked, or the dark color may be carried to the first dorsal scales. Laterally the horns of the crescent rarely extend forward of the eye. The light dorsal scales (end-to-end) between the head crescent and the first dark band on the neck vary from 3 to 9, with a mode of 5 or 6.

As to the typical representative colors of live specimens of this subspecies, I present the Ridgway colors of specimens from the mesas east and west of the Imperial Valley, in Imperial County, California:

	Dixieland	*Sand dunes 14 mi. w. of Yuma*
Snout (except rostral)	Yellowish Glaucous	Pale Chalcedony Yellow
Rostral	Grenadine	Peach Red
Head crescent	Dull Purplish Black	Black
Dorsal bands	Dull Purplish Black	Black
Interspace centers	Grenadine	Peach Red
Interspace edges	Sea-foam Green	Pale Chalcedony Yellow
Ventral bands	Vinaceous Slate	Warm Blackish Brown
Ventral interspaces	Sea-foam Yellow	Pale Chalcedony Yellow

In general, live specimens of *annulata*, when from the center of the range of this subspecies, are black-ringed, with bright suffusions of pink or red in the interspaces, on a cream or white background. The red is often even-edged, leaving a single row or light scales between the red and black. The red, however bright and clear it may be, and however much like a true ring dorsally, is never complete on the ventrum, but always terminates laterally one or more scale rows above the ventrals.

Intrasubspecific Trends.—The area inhabited by the most typical specimens of *annulata*, that is, those most widely differentiated from the other *occipitalis* subspecies, comprises the eastern and western borders of the Imperial Valley, in Imperial County, California; and the Yuma Desert as far east as Mohawk, in Yuma County, Arizona. Outside of this area *klauberi* and *occipitalis* influences are shown in several ways, particularly by the interblotch maculations in snakes from the eastern border, and a change from black to brown bands, with a suppression of the red interband suffusions or saddles in western specimens.

If the scale counts be restricted to the snakes of the central area, we have the following data: Ventrals, males, range 147 to 164, mean 156.6; females, range 161 to 177, mean 168.1; subcaudals, males, range 43 to 57, mean 50.5; females, range 41 to 51, mean 45.5.

Comparing these counts with those of snakes from border areas, we find that typical *annulata* has more ventrals and subcaudals, on the average, than the fringe populations, whether to the west in San Diego County, or to the east in southern Maricopa and western Pima counties. The differences in numbers of scales from the San Diego averages are as follows, the Imperial–Yuma specimens being always higher: Ventrals, males 4.0, females 6.2; subcaudals, males 3.6, females 3.9. These differences may be caused by the higher temperatures to which the Imperial–Yuma snakes are subjected, or to their larger size; it is known that both of these conditions lead to average increases in the number of scales. There are no conspicuous differences in ventral and subcaudal scales between the Imperial–Yuma snakes and those of northwestern Sonora.

The divergence in pattern between the populations from the fringe areas and those from the central Imperial–Yuma area is more marked than in squamation, the differences being not only numerical but of form and color as well.

The Imperial–Yuma snakes are characterized by well separated, black crossbands. The bands are almost never as wide as the interspaces; in fact, in the majority of specimens the interspaces are almost twice as wide as the bands. Also, in most specimens, an interblotch suffusion of pink or red is present in life to a marked degree, so definite, in fact, as to form a well-defined saddle. There is usually a spot of pink on the rostral. The head crescent is narrower than it is in the fringe-territory specimens; it often leaves both the frontal and the posterior edges of the parietals clear, and the lateral horns rarely reach the preoculars.

The statistics of the bands are given in the following summary, the San Diego County data being supplied for comparative purposes:

	Imperial–Yuma Counties	*San Diego County*
Body bands, range	18–35	19–35
mean	23.9	24.8
Tail rings, range	5–11	5–10
mean	7.7	7.6
Body bands plus unmarked ventral blotch positions, range	20–40	20–59
mean	28.0	36.7

It will be observed that the only important difference is in the combination category of body bands plus unmarked ventral blotch positions, for the first ventral marks in the San Diego series usually occur farther back than in the Imperial–Yuma snakes. This is apparently an *occipitalis* influence, as are some of the other divergences of the San Diego County snakes from the more typical

Imperial–Yuma population. Although the San Diego specimens usually have black dorsal bands, dark-brown bands are not rare. The dorsal patterns of the San Diego snakes are, in fact, particularly variable, the bands being diverse not only in color, but also in relative width. The superiority of the interspaces in width, as compared with the bands, as evident in the Imperial–Yuma series, is not so manifest in the San Diego population, wherein bands equal to, or exceeding, the interspaces in width are quite common. Snakes with wide bands are most frequent at the higher altitudes on the extreme western fringe of the range, at such mountain-foothill localities as Mountain Spring, La Puerta, and lower Sentenac Canyon. In some of these, the bands are so wide as to comprise large dorsal blotches; for example, in a specimen from Yaqui Pass, the dorsal blotches are 5 scales wide (end-to-end) and the interspaces only 2 scales. In contrast, a specimen from Clark Dry Lake, out on the flat area of the Borrego Valley, is exactly reversed, with bands 2 scales wide and interspaces 5. Another specimen has a superabundance of melanin resulting in a blackened snout, dark scale edges in the interspaces, and a heavily mottled ventrum between the normal ventral bands.

The interspace colors are also highly variable in the San Diego County series. The following Ridgway shades were observed in 20 live specimens; these may be compared with typical Imperial County colors listed on p. 165.

	Interspaces	
Dorsal bands	*Centers*	*Dorsal edges*
Dusky Purplish Gray	Colonial Buff	White
Blackish Brown (1)	Warm Buff	Ivory Yellow
Blackish Brown (2)	Cinnamon Buff	Sea-foam Yellow
Blackish Brown (3)	Ochraceous Buff	Naphthalene Yellow
Dull Violet-Black	Sea-foam Yellow	Light Chalcedony Yellow
Fuscous Black	Honey Yellow	Marguerite Yellow
Aniline Black	Flesh-Ochre	Martius Yellow
Black	Mikado Orange	Massicot Yellow
	Bitter Sweet Orange	
	Apricot Orange	
	Ochraceous Orange	
	Light Salmon Orange	
	Zinc Orange	
	Grenadine	
	Ochraceous-Salmon	
	Carrot Red	
	Carnelian Red	

Just as the bands become wider, with the transition from a flat, sandy habitat to one of rocky foothills, so also the reds of the interspaces are changed to yellow or buff.

On the opposite side of the *annulata* range, in the Gila Bend–Ajo area, there is, as might be expected, a *klauberi* influence. Compared with the Imperial–Yuma series, the ventrals and subcaudals are low, and the body bands somewhat high, in number. There is usually an orange suffusion in the interspaces with considerable dark spotting on the sides (the most evident *klauberi* influence). The interspace saddles, whether orange, or maculated with brown scale edges, are usually 1 scale wide dorsally, and 2 wide laterally.

Along the Sonoyta–Punta Peñasco road in northwestern Sonora, somewhat the same tendencies are to be observed; however, the snakes of this area differ from those of the Gila Bend–Ajo section in having more ventrals, in which character they are nearer to typical *annulata*. They are like the Gila Bend–Ajo series in the color and shape of the body bands, and in the presence of maculations in the lateral interspaces. The red or orange interspace saddles, whether or not carrying the brown maculations relating them to *klauberi*, are quite narrow—1 scale wide dorsally and 2 or 3 laterally.

The following were the dorsal body colors of 3 specimens from the vicinity of El Papalote, Sonora: Dark bands—Dull Violet Black, Dull Purplish Black, Black; interspace centers—Japan Rose (only 1 scale wide, with dark spots on anterior tips of scales), Carnelian Red (only 1 scale wide, mostly on the anterior scale tips), Grenadine Red; interspace edges—Naples Yellow, Naphthalene Yellow, Straw Yellow.

Specific and Subspecific Relationships.—The subspecies *C. o. annulata* intergrades with both *C. o. occipitalis* and *C. o. klauberi* in ways that have been indicated, both in discussing intrasubspecific variation in *annulata* and also in the treatment of the other two subspecies. There remain only the subspecies of *C. palarostris* to mention. Of all the subspecies of *C. occipitalis*, *annulata* most nearly resembles *C. palarostris* in pattern, for *annulata* is characterized by black rings, which are both narrower and fewer in number than in the other *occipitalis* subspecies, and has more red in the interspaces. Both of these characters are carried to a still further extreme in *palarostris*, although somewhat less so in *p. organica* than in *p. palarostris*. Were these details of pattern the only differences, one might expect an intergrading population to be found between *annulata* near Colfred and *organica* in the Organ Pipe Cactus National Monument, by way of Mohawk Valley. But *organica* is notably low in ventral scale counts, whereas *annulata* is high. In addition, the convex crown of *organica* contrasts with the flatter and sharper snout of *annulata*. For these reasons, although intergradation between *organica* and *annulata* is a possibility—which would make *Chionactis* monotypic—the present evidence is against the idea.

Range.—*Chionactis o. annulata* is found in the desert foothills and desert areas of San Diego County,* and in Imperial County (except northeast of the Chocolate Mountains), California; Yuma County, western and southern

*USNM 59465 from the "San Diego River Valley" almost certainly has an incorrect locality assigned to it. In spite of the most intensive collecting during the last 30 years, no other cismontane specimen, not known to have escaped from captivity, has come to light in southern California.

Maricopa County, and northwestern Pima County, Arizona; and in Sonora, Mexico, from Sonoyta west and southwest. Although *annulata* has not yet been reported from Baja California, it certainly occurs there, as it has been taken within a mile or so of the border at several points between Calexico and Winterhaven. Tracks, quite probably of *Chionactis,* have been seen at San Felipe about 120 miles south of the border, on the Gulf of California coast.

Locality Records.—CALIFORNIA: *Riverside County*—1 mi. nw. of Travertine Rock (*occipitalis* intergrade); *San Diego County*—Clark Dry Lake (also 1.2 and 2 mi. s.), Beatty's (Borrego Valley), Borrego Spring, Christmas Tree Circle (Borrego Valley), Yaqui Pass (also 2 mi. ne.), foot of Sentenac Canyon, Yaqui Well, The Narrows, Bensons Dry Lake (= Ocotillo) (specimens have been collected on Cal. 78 every hundred yards or so from Yaqui Well via The Narrows to the County Line east of Ocotillo, a distance of 18½ mi.), San Felipe Wash, Halfhill Dry Lake (old San Felipe townsite), La Puerta, Vallecito, Agua Caliente Spring, Carrizo Spring; *Imperial County*—Travertine Rock (*occipitalis* intergrade), Sea View, San Felipe Wash, San Diego–Imperial County line at Cal. 78 (also 2 and 5 mi. e.), Kane Spring (also 1½, 3, and 5 mi. nw., and 4, 5, and 8 mi. w.), Calipatria, Alamorio, Brawley, Imperial, Mountain Spring (also 2 and 3 mi. e.), Coyote Wells, Plaster City, Dixieland (also 1 mi. w.), Seeley (also 3 mi. w.), Calexico (also 3 mi. w.), Bonds Corner, Meloland, Holtville (also 14 mi. se.), Drop 3 (on the All-American Canal), Midway Well (junction U.S. 80 and Cal. 98) (also 1 and 8 mi. w., and 6 mi. ne.), Grays Well (also 1, 2, and 5 mi. w.), Chocolate Mts., Winterhaven (also 10 and 14 mi. w.), 14 mi. w. of Yuma (Arizona), Pilot Knob, Pilot Knob R.R. Sta., Colorado River (near Pilot Knob).

ARIZONA: *Yuma County*—6 mi. s. and 15 mi. se. of Parker, 9 mi. s. of Quartzsite, 2 mi. e. of Dunn (= 10 mi. e. of Brenda), Yuma (also 5 mi. e.), Yuma Mesa, Monument 200 (= Arizona–Sonora boundary, 15 mi. e. of Colorado River), Dublin (also 7 mi. w.), south Gila Valley, Fortuna Wash (15 mi. e. of Yuma), Wellton Mesa, Wellton (also 4 mi. e.), Tacna (also 5 mi. e.), Lugar Bonita (= 12 mi. e. of Wellton), Pembroke, Mohawk (also 5 mi. e. and 7 mi. w.), Chrystoval (= Stoval), bet. Roll and Maricopa County line; *Maricopa County*—2½ mi. e. of Aguila, 7 mi. sw. of Wickenburg, Cactus Garden (=3 mi. nw. of Morristown), Sentinel (also 2 mi. e.), Gila Bend (also 7, 15, and 28½ mi. s., and 12 mi. e.), 7 mi. s. of Black Gap, Midway (Black Gap and Midway are stations on the Tucson, Cornelia, & Gila Bend R.R.), 24 mi. n. of Ajo (Pima Co.); *Pima County*—7 mi. se. of Ajo, Gunsight Junction (= Ajo–Tucson–Sonoyta road junction) (also 2 mi. nw.).

SONORA: 25 mi. s. of San Luis, ½ way bet. Sonoyta and Punta Peñasco, 23 mi. sw. of Sonoyta, 11 and 20 mi. sw. of Pozo Sipiano, El Papalote (also 2, 6, and 14 mi. ne., and 1 and 4 mi. sw.), 6½, 9, and 16 mi. ne. of Punta Peñasco, 8 mi. n. of Rocky Point (= Punta Peñasco).

With regard to intergrades between *annulata* and *klauberi,* it should be stated that all of the snakes in the Wickenburg, Gila Bend–Casa Grande, Gila

Bend–Ajo, and Sonoyta–Punta Peñasco sections show *klauberi* tendencies in various degrees. Specimens from the following places show these tendencies to a sufficient degree to be considered integrades: *Maricopa County*—2½ mi. e. of Aguila, Gila Bend (also 15 mi. s.), and 24 mi. n. of Ajo; *Pinal County*—near Casa Grande (locality somewhat indefinite); *Pima County*—Gunsight Junction; *Sonora*—1 and 2 mi. sw. of El Papalote, and 6½ mi. ne. of Punta Peñasco (= 7½ mi. sw. of El Papalote). It appears that the *klauberi* influence is somewhat spotty, being concentrated in some areas of the general border between the subspecies. Even in these the effect is not uniform, for it is evident in some specimens but not in others collected at the same place.

Chionactis occipitalis klauberi (Stickel)

TUCSON SHOVEL-NOSED SNAKE

1941. *Sonora occipitalis klauberi* Stickel, Bull. Chicago Acad. Sci., vol. 6, no. 7, p. 138. Type specimen LMK 29647; type locality Tucson, Pima County, Arizona.

1943. *Chionactis occipitalis klauberi* Stickel, Proc. Biol. Soc. Wash., vol. 56, p. 124.

Diagnosis.—This subspecies of *Chionactis occipitalis* is characterized by dark secondary crossbands occupying the centers of the interspaces between the primary black crossbands. In the typical specimens the secondary bands are complete moddorsally. They widen laterally but do not reach the ventrum. The new subspecies *C. o. talpina* is the only other one having dark (non-red) secondaries; in *klauberi* the primary bands are black, or nearly so; in *talpina* they are brown. *C. o. talpina* has more ventral plates than *klauberi.*

Systematic Problems.—In the area from Tucson, Pima County, Arizona, northwest to Picacho, and thence north to Florence and Florence Junction, in Pinal Co., most specimens of *Chionactis* are typical *klauberi.* Intergradation with *annulata* begins at Casa Grande, and is noted as far west as Gila Bend, north to Aguila, and south to Ajo. Although most of the specimens from the Sonoyta–Punta Peñasco road in northwestern Sonora are to be considered *annulata,* some evince *klauberi* tendencies to a noticeable degree, which is all the more surprising, since a population of *palarostris organica* occupies the Organ Pipe Cactus National Monument, situated between these Sonoran intergrades and the *klauberi* headquarters in the Tucson–Florence area.

Material.—Of typical *klauberi* I have had 17 specimens available, of which 7 are females.

Description of the Subspecies.—This is a snake of the usual *Chionactis* form, with the inset lower jaw and sharp rostral characteristic of the genus. The shortest specimen at hand is a female 157 mm. in length; the longest, a male and a female each measuring 339 mm.

The tail in the adult males is about 19 per cent of the length over-all, and in the females about 16 per cent.

The scale rows number 15. The ventrals in the males range from 141 to 151, mean 145.8; and in the females from 153 to 159, mean 156.0. The corresponding subcaudal counts are 42 to 47, mean 44.4; and 38 to 43, mean 40.4. The labials, both upper and lower, number 7. The nasals, loreals, and preoculars are single; the postoculars paired, except in one specimen that has a single postocular on one side. The temporals are 1+2, except in one specimen having 1+1 on the left.

The black head crescent is quite broad on top; it not only marks the supraoculars, but is carried back to the first dorsal scales behind the parietals. At the frontal, there is often a deep light indentation or notch that serves to lighten the frontal itself. On the sides the points of the crescent are carried forward to mark the nasals. The ground color of the snout, anterior to the crescent, is somewhat darkened, compared with the rest of the ground color.

The primary rings on the body range in number from 23 to 29 with a mean of 26.7, and on the tail 7 to 11, mean 8.1. The body rings plus the unmarked ventral ring positions vary from 25 to 40, mean 30.1. The rings are usually narrower middorsally than the interspaces, but may be equal, or, rarely, wider. The dorsal marks narrow laterally, and then widen again on the ventrum. The first ring completely encircling the body ranges from the fifth to the twelfth ring. On the ventrum the rings again widen, more so, in fact, than in any other subspecies; posteriorly, they usually engage 3 or 4 ventrals. Between the primary rings there is a secondary dark series, more conspicuous in this than in any other subspecies. The secondary rings are narrowest middorsally; they are usually separated from the primary series by a single row of immaculate scales, and thus the secondaries widen on the sides where the primaries become narrower. Laterally, the secondaries end on the first or second row of scales above the ventrals. The dark color of the secondaries is never as dense as that of the primaries; often only the centers of the scales are darkened and thus some of the ground color may show through, or a pink suffusion may do so, particularly on the tail. Breaks in the secondary rings occur most often middorsally. The basic color of the secondaries may be black or brown, but the pink suffusion often gives them a purplish cast. The ground color is white, cream, or light-yellow.

Intrasubspecific Trends.—In the Tucson–Marana–Picacho–Florence–Florence Junction area, *klauberi* seems to be a rather consistent form. With a single exception, all of the specimens of *Chionactis* that I have seen from this territory clearly belong to this subspecies. True, only about half the specimens have complete secondary bands middorsally, but all have darkened scale centers in the lateral scales comprising the secondaries, whereas it is characteristic of most *annulata–klauberi* intergrades that only the scale edges are darkened. In the *klauberi* territory, the secondary rings are more often complete dorsally in the Florence area than farther south at Marana.

The single specimen from *klauberi* territory failing to agree with the others in pattern is No. 422 in the Woodin collection. This is said to have been taken on the San Xavier Road near Tucson (it was not collected by Mr. Woodin himself). It has none of the characteristics of *klauberi*, or even of *annulata*, but resembles *occipitalis* from Riverside Co., California. Unless there is some error in the locality record, it is a very queer specimen indeed.

Relationships with Other Subspecies—To the northwest of the *klauberi* territory comparatively few specimens are available. There are 2 from the general vicinity of Casa Grande, Pinal County,—the exact points of collection are not known—one of which favors *klauberi*, while the other shows an *annulata* affinity. From the Wickenburg area only 2 specimens are at hand; one is from Cactus Garden, northwest of Hot Springs Junction, and the other is from 2½ miles east of Aguila. Both show *klauberi* influences, the latter somewhat more than the former, although it was collected about 25 miles farther away from the *klauberi* territory.

From southern Maricopa County, south of Gila Bend, and thence south to somewhat beyond Ajo, in Pima County, a fairly adequate series is available. The interspaces are almost always spotted to some degree. I consider this to be an area of intergradation, in which most of the specimens favor *annulata* more than *klauberi*.

Southwesterly in Sonora, along the road between Sonoyta and Punta Peñasco, occurs another intergrading population. In these snakes, the dark color in the interspaces is nearly always restricted to scale edges. All fresh specimens show pink suffusions in the interspaces. Though the *klauberi* affinity is clearly evident, I consider this series nearer *annulata*.

Farther west in the vicinity of Yuma an occasional specimen shows faintly the *klauberi* secondaries; and even in California, as I have discussed elsewhere, this darkening to form secondary bands is sometimes evident to a moderate degree.

Locality Records.—Specimens of *klauberi* have been collected at the following points: ARIZONA: *Pima County*—Tucson (type locality), Marana (30 and 32 mi. nw. of Tucson); *Pinal County*—6.4 mi. se. of Red Rock, 3 mi. se. of Pichacho, 3, 4.7, and 10 mi. n. of Florence (7 mi. s. of Florence Junction), Magma Junction, 5.5 and 8.3 mi. s. of Florence Junction. To complete the locality list, the following are to be considered records of *annulata-klauberi* intergrades, as discussed more fully under the former subspecies; ARIZONA: *Maricopa County*—2½ mi. e. of Aguila, Gila Bend (also 15 mi. s.), and 24 mi. n. of Ajo; *Pinal County*—near Casa Grande; *Pima County*—Gunsight Junction; SONORA—1, 2, and 7½ mi. sw. of El Papalote.

Chionactis occipitalis talpina* subsp. nov.

NORTHERN SHOVEL-NOSED SNAKE

Plate 10, fig. 1

There have lately been collected in Nevada, considerably to the north of any specimens hitherto known from that state, and about 75 miles northeasterly of the nearest specimen from California, 3 specimens of *Chionactis* that justify subspecific segregation from their territorially closest relatives. Two of the 3 specimens are from a higher altitude than any previously known to be inhabited by *Chionactis*.

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*Mole-like, to denote its fossorial habit.

Type Specimen.—California Academy of Sciences number 81364. Found dead on the road by Joseph R. Slevin and Wallace Wood, 50 miles south of Goldfield on the highway to Beatty, in Nye County, Nevada, June 3, 1947.

Diagnosis.—A subspecies differing from the subspecies of *palarostris,* and from the other subspecies of *occipitalis* except *klauberi,* in having, in the interspaces between the main series of the crossbands, dark marks that give the effect of secondary brown crossbands. From *klauberi* it differs in having more ventrals, and in having brown, instead of black, primary bands.

Description of the Type.—An adult male. The length over-all is 284 mm. and the tail length 52 mm.; ratio .183. The body is of normal *Chionactis* configuration, and it has the important *Chionactis* characters of nasal valves, abdominal angle, and protruding flap on the mental. The pupil is round. The dorsal scale rows are 15–15–15, all smooth, and with single apical pits.

There are 153 ventrals, the anal is divided, and the subcaudals, all divided, number 44. The head scales are normal for the species, with one loreal on each side, one preocular, two postoculars (the upper larger) and the temporals 1+2. The supralabials number 7–7; the third and fourth enter the orbit, and the sixth is the largest. The infralabials are 7–7.

The body pattern comprises a series of dark-brown crossbands, 27 on the body and 7 on the tail. They are considerably wider than the interspaces, being about 4 scales long (end-to-end) while the interspaces cover 2. All bands except the first on the neck touch the ventrals, and all but the first 2 cross the ventrum and thus become complete rings. The bands narrow laterally; the posterior ones again widen at the ventrum. The primary bands are somewhat darker dorsally than on the sides and ventrum. In the interspaces the ground color is cream, but the central scales are heavily blotched with dark-brown, although the edges of the maculated scales are usually clear. On the sides, the secondaries widen somewhat, but the maculations become less intense at the lowest 2 rows of the lateral scales; on the ventrals the interspace maculations are represented by scattered punctations.

The head crescent is quite wide, extending from the middle of the supraoculars and frontal to the posterior edge of the parietals. The snout is somewhat punctated above, and there are several spots on the labials and lower jaw, where other forms of *Chionactis* are usually clear.

Paratypes.—There are 2 paratypes, LMK 39520–1, collected by Eric Comstock and Verne Larson 10 miles north of Goldfield, Esmeralda County, Nevada, on the road to Tonopah, in July, 1949. Although taken 60 miles north of the type locality, and at a higher altitude (about 5500 ft.), they are not as extreme in pattern as the type, for the characteristic brown maculations in the interspaces do not cross the dorsum. However, they have higher ventral counts.

No. 39520 is an adult male, length over-all 335 mm., tail length 66 mm. The scale rows are 15–15–15, the ventrals number 162 and the subcaudals 51, all divided. All labials are 7–7.

The head crescent extends across the parietals; its lateral horns extend forward to the nasals. There are 32 primary crossbands on the body and 9 on the tail. The anteriormost band marking the ventrum is the fourth, and the first comprising a complete ring is the sixth. The dorsal bands, wider than the interspaces, extend longitudinally for slightly less than 3 scales, end-to-end, while the interspaces measure 2½. Scales less than half maculated are usually lighter than their fellows in the bands. The bands narrow laterally, and are both lighter and narrower on the ventrum. Posteriorly, the bands on the ventrum become wider and darker. Between the main dorsal blotches the interspaces are maculated with brown, particularly at scale centers.

The colors in life (Ridgway) were as follows: The snout was Reed Yellow, the crescent Mummy Brown. The primary dorsal bands were mostly Warm Sepia, but Rood's Brown at their lower edges. The interspaces were Colonial Buff with spots of Light Ochraceous Salmon; the maculations were Rood's Brown. The ventral surface was Pale Olive-Buff and the rings Rood's Brown. There were Maize Yellow spots on the tail between the primary blotches. The eye was Black.

The second paratype, an adult female containing 3 eggs, has a length over-all of 340 mm. and a tail length of 56 mm. The ventrals number 162 and the subcaudals 43. There are 33 primary bands on the body and 11 on the tail. None of the primary bands crosses the ventrum; instead, the ventrals are generally speckled with brown. However, the rings are complete on the tail. The colors in life were much the same as in the other paratype, but the maculations in the interspaces are heavier.

Relationships.—Although *talpina* superficially resembles *klauberi* in having dark bands in the interspaces, it is doubtful whether the two are closely related, or that there is or ever has been any territorial interconnection between them. As *klauberi* intergrades with, and was evidently derived from *annulata,* so *talpina* intergrades with, and is apparently a darkened derivative of *occipitalis.* Southward and southeasterly of the *talpina* territory, intergrades are already at hand that comprise a logical geographic pattern. Southwesterly none is yet available.

MVZ 40977, from Indian Springs, Clark County, Nevada, is a faded specimen with some maculations in the interspaces. Farther to the southeast, at Boulder City in the same county, the snakes seem to be pure *occipitalis.* Southward of the *talpina* area, the nearest available specimens are Stanford 9218 and 9219 from 11 and 16 miles south of Shoshone, the first locality being in Inyo County, the second in San Bernardino County, California. Also there is CAS 65380 from Goler Canyon, Panamint Mountains, Inyo County, and LMK 35549 from 1 mile east of Leach Lake, San Bernardino County. All of these have brown spots in the interspaces laterally, although seldom middorsally; they are to be considered *talpina–occipitalis* intergrades. No other specimens are yet available from this area immediately below Death Valley, but to the extent that specimens are at hand, the pattern trend is quite consistent.

From the southwest of the *talpina* area only a single *Chionactis* (CNHM 1714, from Owens Lake, Inyo County) is available. Since this rather faded specimen shows no interspace maculations, it is to be considered pure *occipitalis*.

The question may well be asked as to the frequency of occurrence of *talpina*-type maculations among specimens of *occipitalis* available from southern and western San Bernardino County, and eastern Kern County, from which area I have at hand about 100 specimens. I find that snakes with a few scattered dots in the interspaces are by no means unusual; probably 25 per cent of the population have such dots. Of snakes with marked *talpina* tendencies, strong enough to be considered intergrades, were they from fringe areas, there are 4: LMK 31686 from Minneola, LMK 31687 from Hector, LMK 39961 from 6 miles north of Adelanto, and UCLA 506 from 2 miles west of Barstow. Of these, the Hector specimen is the most surprising, as it is heavily maculated across the dorsum. But I do not consider that these territorially inconsistent, aberrant specimens of *occipitalis* invalidate *talpina*, any more than *klauberi* is invalidated by the circumstance that scattered specimens of *annulata*, in San Diego and Imperial counties, have *klauberi* tendencies.

One other specimen, MCZ 9806, from a questionable locality, should be mentioned. It is reputed to have been collected in southern Utah, but Mr. Arthur Loveridge informs me that this is to be considered doubtful. No other *Chionactis* has yet been reported from that state. Superficially it looks like *talpina*, having brown primary bands, and lighter brown secondaries. Yet it could be a badly faded *klauberi*, since the ventrals are low for *talpina* (it is a male with 146), and it has two other *klauberi* characteristics—a frontal notch in the head crescent, and marked widening of the posterior rings on the ventrum.

Localities.—The subspecies *talpina* is known only from the type locality: 50 miles south of Goldfield, in Nye County, Nevada, on the Beatty road; and from 10 miles north of Goldfield, Esmeralda County, Nevada, on the Tonopah road.

Areas of intergradation with *C. o. occipitalis* are indicated by the following localities where intergrades have been collected: near Indian Springs, Clark County, Nevada; 11 miles south of Shoshone, and Goler Canyon, Panamint Mountains, Inyo County, California; and 16 and 22 miles south of Shoshone, and 1 mile east of Leach Lake, San Bernardino County, California.

Chionactis palarostris palarostris (Klauber)

SONORAN SHOVEL-NOSED SNAKE

1937. *Sonora palarostris* Klauber, Trans. San Diego Soc. Nat. Hist., vol. 8, no. 27, p. 363. Type specimen LMK 26771; type locality 5 miles south of Magdalena, Sonora, Mexico.

1941. *Sonora occipitalis palarostris* Stickel, Bull. Chicago Acad. Sci., vol. 6, no. 7, p. 137.

1943. *Chionactis occipitalis palarostris* Stickel, Proc. Biol. Soc. Wash., vol. 56, p. 128 [= 123].

Diagnosis.—A subspecies having a more convex snout than any of the subspecies of *occipitalis*, also fewer ventrals (on the average), and fewer crossbands on the body and tail. It has fewer crossbands and relatively wider interspaces than the subspecies *palarostris organica.*

Systematic Problems.—I originally described this form as a full species. Subsequently Stickel (1941, p. 137) reduced it to subspecific status, on the inference that specimens from intermediate territory would demonstrate intergradation. At that time only two specimens of *palarostris* were available to him—the type and MCZ 36890 from Costa Rica Ranch, some 40 miles to the westward of Hermosillo, Sonora. Recently an additional population of *palarostris* has been discovered in the United States, through the activity of W. R. Supernaugh, M. Max Hensley, and others collecting in the vicinity of the Monument headquarters at the Organ Pipe Cactus National Monument, on the road from Ajo, Pima County, Arizona, southward to Sonoyta. These U. S. specimens, although not as extreme as the type in low blotch counts, do have the convex snout of *palarostris,* and have fewer body bands than *annulata.* They differ in these characters from 12 specimens of *annulata* (or *annulata–klauberi* intergrades) from Gila Bend to Gunsight, as well as from another series of 15 specimens of *annulata* collected between Sonoyta and Punta Peñasco, in Sonora. This newly discovered *palarostris* population is known to extend at least 20 miles along the highway through the Monument, from 2 to 22 miles north of the U.S.–Mexican border. The nearest specimen of *annulata* available from Sonora was collected only 26 miles distant from the southernmost of this *palarostris* population, yet there is no indication of intergradation between the two. In the interval of about 7 miles separating the populations of *palarostris* and *annulata* north of the Monument, there are some suggestions of intergradation in pattern, but the snout difference remains uncompromised. Therefore, I conclude that *palarostris* should be retained as a valid species, unless further collecting in this area should demonstrate intergradation. An actual overlap between the two populations is by no means impossible.

Of the two specimens of *palarostris* hitherto available from Sonora, the type, from 5 miles south of Magdalena, shows certain well-marked differences from both the Costa Rica Ranch specimen and the Organ Pipe population previously mentioned. During the past summer an additional west-central Sonoran specimen was collected by R. G. Zweifel and K. S. Norris, at a point 40.7 miles south of Hermosillo, or about 150 miles (straight-line distance) south of the type locality.* This has all of the outstanding pattern features of the type, thus indicating that these are characteristic of the population of that area. I have therefore decided to consider the Magdalena-Hermosillo population as subspecifically distinct from the Organ Pipe, assigning the new name *organica* to the latter.

Material.—Two specimens of the subspecies *palarostris palarostris* are available.

Description of the Subspecies.—This is a snake of the usual *Chionactis* configuration, except that the rostral is blunter, and the top of the head, from

*The nearest named place to this locality is the hamlet of El Pocito some 3 miles northward. I shall hereafter refer to this as the Pocito specimen.

the center of the frontal to the snout, is distinctly convex, whereas in the subspecies of *occipitalis* it is virtually straight, or slightly concave, at the prefrontals.

Of the two specimens available, the type is an adult male with 144 ventrals and 39 subcaudals; the Pocito specimen is a female with 152 ventrals and 42 subcaudals. The scale rows in both number 15, the supralabials 7, infralabials 8, the nasals are undivided, the loreals and preoculars single, the postoculars paired, and the temporals 1+2 or 1+3. The ratios of the tail length to length over-all (both are adults) are .183 in the male and .166 in the female.

The pattern comprises alternating black and deep red blotches or saddles, separated by narrow borders of yellow ground color, which becomes white after preservation. In both specimens there are 10 black blotches on the body and 3 on the tail. The black blotches have a longitudinal extent of only 1/3 of the interspaces, the latter having a length of about 10 to 12 scales (end-to-end), whereas the black blotches cover 3 to 3½ scales middorsally, where they are widest. The red saddles have about 4 times the extent of the narrow yellow stripes that border them.

Both the black and red blotches narrow on the sides, so that laterally the ground color is more in evidence than dorsally. The black blotches rewiden ventrally, but the red saddles fade out at the first row of scales above the ventrals. Laterally the red saddles are maculated with black spots; these are much less prominent in the type than in the Pocito specimen, in which they are carried to the ventrum.

In this subspecies the snout is cream-colored. There is a large black parietal blotch covering the posterior 2/3 of the frontal and extending to the rear edges of the parietals; on the sides this blotch engages the eyes and the upper edges of the posterior supralabials. Although this blotch is analogous to the crescent characteristic of all subspecies of *occipitalis,* it is more rectangular in form. The underside of the head is cream. There are 14 to 16 scales, end-to-end, between the head blotch and the first dorsal body band.

Shortly after preservation, the type exhibited the following Ridgway dorsal colors: Black, Brazil Red, and Maize Yellow, with a Cream Color ventrum.

Intrasubspecific Trends and Relationships.—With only 2 typical specimens available, no conclusions respecting trends can be drawn. The most conspicuous difference between the Magdalena and Pocito specimens is the interspace maculations of the latter.

Based on the available material, *palarostris palarostris* is subspecifically distinct from the snakes of the Organ Pipe Cactus National Monument. I shall discuss this relationship under the new subspecies.

There remains MCZ 36890 from Costa Rica Ranch, Sonora, a locality some 40 miles west and slightly south of Hermosillo. In all important characters, particularly in the number and relative spacing of the blotches, this specimen resembles the new subspecies *organica,* rather than *p. palarostris.* It is a juvenile and the preservation is not good. It is not possible to tell whether the snout is sharp as in *occipitalis* or blunter as in *palarostris.* Only additional collecting in this relatively inaccessible area will determine whether this is a *palarostris* of unusual pattern, an *organica* involving a very long range extension, or an *annulata* far from its nearest relatives and with a sufficiently low blotch count to warrant a separate subspecific status. The latter is not an impossibility, having in mind the equally surprising territorial relationship between *C. o. annulata* and *C. p. organica* in western Pima County and northwestern Sonora.

Thus far, *Chionctis* has not been collected between a point only a few miles south of Tucson and Magdalena, although considerable night collecting has been tried on the road from Tubac south to Nogales. It seems rather doubtful whether a continuous *Chionactis* population exists over this direct line from Tucson to Magdalena via Nogales, hence there is little probability of a direct contact between the populations of *klauberi* and *p. palarostris* as represented by their most typical forms.

Range.—*Chionactis p. palarostris* has been collected 5 mi. s. of Magdalena, and 40.7 mi. s. of Hermosillo (near El Pocito), Sonora, Mexico. There is a specimen of uncertain status from Costa Rica Ranch, Sonora.

Chionactis palarostris organica* subsp. nov.

ORGAN PIPE SHOVEL-NOSED SNAKE

Plate 10, fig. 2

1950. *Chionactis occipitalis palarostris* Hensley, Trans. Kansas Acad. Sci., vol. 53, no. 2, p. 283.

Type Specimen.—LMK 40673. Collected by William R. Supernaugh and Grover E. Steele at 9:42 P.M., May 22, 1950, on the Sonoyta–Ajo road, 9 miles north of the U.S.–Mexican Border, in the Organ Pipe Cactus National Monument, Pima County, Arizona. Preserved July 19, 1950.

Diagnosis.—A subspecies differing from all *occipitalis* subspecies in having a blunter snout and fewer body blotches. From *palarostris palarostris* it differs in having more body blotches, and in possessing red saddles shorter than, or only equal to, the black blotches, whereas in *p. palarostris* the red saddles are more than twice the length of the black.

Description of the Type.—An adult male. The length over-all was 303 mm. and the tail length 58 mm.; ratio .191 (before preservation). The body is of the usual *Chionactis* shape, and it possesses the nasal valve, abdominal angle, and protruding flap on the mental characteristic of the genus. The snout is blunter and more convex on top than in *occipitalis*. The pupil is round. The dorsal scale rows are 17–15–15, all smooth.

There are 146 ventrals, a divided anal, and 42 subcaudals, all divided. There are 7 supralabials on each side; the third and fourth touch the eye, and the sixth is the largest. The infralabials also number 7. The nasals, loreals, and preoculars are single, the postoculars paired. The temporals are 1+2.

The body pattern comprises a series of 14 black blotches or saddles; there are 4 blotches on the tail. Middorsally the saddles engage 4 scales,

*To indicate its habitat in the Organ Pipe Cactus National Monument.

end-to-end, while the interspaces comprise 6 scales. The anterior edge of the first blotch is 5½ scales back of the parietals. The black saddles narrow laterally and then rewiden on the ventrum. The first saddle to mark the ventrum is the third from the head, and the first to comprise a complete ring is the fifth. Between each pair of black blotches there is a vermilion saddle extending for about 3½ scales. Although bright and clear, the vermilion blotches are not as sharp-edged as the black; laterally they fade out on the second or third row of scales above the ventrals. A few of the vermilion scales have darkened edges.

The head crescent is quite wide, extending from the anterior third of the frontal and supraoculars almost to the posterior edges of the parietals. The anterior lateral points of the crescent reach the loreals. The ground color is cream, somewhat darker dorsally than below.

Paratypes.—There are 14 paratypes available, all collected on the Ajo–Sonoyta road between 2 and 22½ miles north of the International Boundary. These are Cornell 4073, Woodin 651, Illinois 5602–6, 5906, 10625, and 10630, and 4 specimens belonging to the Monument Museum. The following data were compiled from the type and paratypes taken together, comprising 12 males and 3 females.

This is a snake of the usual *Chionactis* configuration but with the blunt snout and convex crown characteristic of *palarostris*, as compared to *occipitalis*. The longest specimen is a female 391 mm.; the longest male is 308 mm. The shortest is 166 mm.

The tail in the adult males varies from 18.5 to 20.8 per cent of the body length over-all, with an average of 19.7; in the females it averages 16.5 per cent.

The scale rows number 15. The ventrals in the males range from 141 to 150, mean 145.6; and in the females from 156 to 161, mean 158.3. The subcaudals in the males range from 42 to 47, mean 44.5; and in the females are either 42 or 43. Both upper and lower labials usually number 7, but rarely there may be either 6 or 8. The nasals, loreals, and preoculars are single, and the postoculars paired. The temporals are 1+2.

The species *palarostris* is the most beautiful of all the forms of *Chionactis* because of the extent and depth of the red coloration in the spaces between the black crossbands. The subspecies *organica* is somewhat less spectacular than *p. palarostris*. The black head crescent, so characteristic of *Chionactis*, becomes almost a rectangle in *organica;* its anterior edge crosses the frontal and supraoculars at, or just behind, their forward edges, and it extends back as far, or nearly as far, as the posterior edges of the parietals. The lateral borders of the black mark follow the upper edges of the supralabials. The black engages the eyes and is carried forward to darken the preocular, particularly its lower half, and sometimes the loreal. There are 4 to 6 scales between the parietals and the anterior edge of the first black crossband; this compares with 14 and 16 in the two specimens of *p. palarostris*.

The black crossbands on the body are widest (measured along the snake) middorsally, narrowing laterally, but again widening—this is especially true posteriorly—on the ventrum. The bands are from 3 to 5 scales long (end-to-end) middorsally, and usually are narrower than the interspaces, which vary from 4 to 7 scales in length. All but the first 1 or 2 black bands are represented by complete or partial rings crossing the belly, except for one specimen, wherein the fifth blotch is the first one carried to the ventrum. Dorsally, the interspaces are colored with deep-red for lengths of 2 to 4 scales; these red saddles widen laterally (where the black bands narrow) but terminate 1 to 3 scale rows above the ventrals. The lowest red scales are often edged with brown. Dorsally and laterally there is a single row of ground-colored scales between the red and black; and, since the ground color is white or yellow, the snake is tricolored in bright, contrasting hues.* But the beautiful red of the live specimens is soon lost in preservation.

In *organica* there is undoubtedly sexual dimorphism in the number of black body blotches, for the 3 females have 18, 18, and 20 respectively, while the males vary from 13 to 16 with a mean of 14.2. The tail blotches number either 4 or 5 in both sexes.

Using the criterion of body bands plus the unmarked ventral spaces opposite the bands, the variation in *organica* is from 14 to 22, with an average of 16.5. This is considerably lower than in any subspecies of *occipitalis*.

Just after it had shed, an adult female of the Organ Pipe series had the following Ridgway colors: snout, Sea-foam Green anteriorly, Deep Sea-foam Green posteriorly; head crescent, Aniline Black; dorsal crossbands, Dull Violet-Black; interspace centers, Scarlet; interspace edges, Pale Chalcedony Yellow; ventral dark marks, Dull Purplish Black; ventral interspaces, Pale Chalcedony Yellow to Pale Dull Green-Yellow, depending on the color of the organs within, for the skin here is slightly translucent. A male, somewhat smaller, exhibited the following life colors: snout, Pale Chalcedony Yellow in front to Pale Dull Green-Yellow behind; head crescent, Dusky Purplish Gray; dorsal crossbands, Black; interspace centers, Scarlet; interspace edges, Pale Chalcedony Yellow; ventral dark marks, Dull Purplish Black; ventral interspaces, Pale Glass Green.

Relationships with Other Subspecies.—*Chionactis p. organica* differs from the subspecies of *C. occipitalis* in having a blunter snout, fewer ventrals, and fewer dorsal crossbands. Territorially, the nearest *occipitalis* specimens available, which belong to the subspecies *annulata,* are from two areas: those from along the Sonoyta–Punta Peñasco road (15 available specimens), and those from the road from Gila Bend south via Ajo to Gunsight. The former show no *organica* affinities; to the extent that they are not typical *annulata,* they tend toward *klauberi,* for they have a high number of narrow crossbands and maculations in the interspaces.

The specimens of *annulata* from the Ajo–Gunsight area, distant only 7 to 15 miles from the most northerly Organ Pipe locality of *organica,* are less conclusive, there being only 3 specimens available from below Ajo. For

*For this reason *Chionactis,* particularly this species and *C. o. annulata,* is popularly confused with the Sonoran coral snake (*Micruroides euryxanthus*). Besides differences in squamation, it may be noted that the red bands of *Micruroides,* unlike those of *Chionactis,* cross the ventrum.

annulata, they are somewhat low in ventrals (males with 147, 149, and 156) but not in body bands (28, 27, 22). The snouts are fairly sharp, and the head marks more crescentic than in *organica.* The red bands in the interspaces are narrower and more maculated (a *klauberi* trend) than in *organica.* Altogether, I deem intergradation or hybridization between the snakes of the Organ Pipe and those from near Gunsight to be improbable, but not impossible.

There are strong morphological reasons for believing *palarostris* and *organica* to be conspecific, yet they are widely separated geographically and no intergrades are at hand. If *organica* is, as has been inferred, a northwesterly intrusion of *palarostris* between two *annulata* populations (Pozo Sipiano–Papalote and Ajo–Gunsight) then eventually *palarostris–organica* intergrades should be found in the vicinity of Altar, Caborca, and Tajitos. These places lie in a relatively inaccessible area, which will for some years lack the paved roads so necessary to facilitate the collection of *Chionactis,* and the solution of this problem may be long delayed. MCZ 36890 from Costa Rica Ranch has many *organica* characteristics and comes from near the range of *palarostris,* yet it is from a point that is territorially inconsistent with its being considered a *palarostris–organica* intergrade.

Locality Records.—At present *organica* is known only from the Sonoyta–Ajo road through the Organ Pipe Cactus National Monument, where it has been taken 2, 4, 4.3, 4.5, 6.5, 8.2, 9.8, 12, 16, 17.5, 18.4, and 22.4 miles north of the International Boundary.*

GENERIC RELATIONS AND INTRAGENERIC TRENDS

It is probable that *Chilomeniscus* is the nearest present-day relative of *Chionactis.* I say this, not because of the really remarkable superficial resemblance in color and pattern between *Chilomeniscus cinctus* and *Chionactis occipitalis,* but because the two genera have certain important characters in common that distinguish them from most other Colubridae, namely, possession of nasal valves, an angled abdomen, a notably sharp snout with a deeply inset lower jaw, and a mental protrusion to close the tongue orifice. These are characters in which both genera differ from *Sonora;* they are characters fitting them for a life on or beneath the surface of sand.

Chilomeniscus is a stouter-bodied, shorter-tailed snake than *Chionactis,* and the snout is even sharper with a more deeply inset under jaw. Although *Chionactis* has head plates conforming to the normal of most genera of Colubridae, *Chilomeniscus* has several distinctive deviations, including (usually) a contact between the rostral and prefrontals, the merging of the nasals and internasals on each side, and the prevailing absence of loreals. Thus, the two genera are quite distinctive; nevertheless, their mutual possession of certain unusual characters suggests a common ancestry.

*The localities recorded by the collectors sometimes refer to the Boundary, and sometimes to the Monument Headquarters or Ajo. To secure uniformity I have referred all localities to the Boundary. The Monument Headquarters are 5 miles north of the Boundary, and Ajo is 38 miles north, these distances being measured along the road.

The nasal valve in *Chionactis* is hinged to the rear edge of the nostril. As it opens, it pulls back toward the eye and slightly inward. The movement can be easily seen in a live specimen. I am unable to determine whether the opening and closing are coincident with breathing. The valve was never seen to close entirely, as it may when the creature is submerged in sand. A drop of water does not cause complete closure.

The relative bluntness of the *palarostris* snout, as compared with *occipitalis,* is somewhat more evident in live than in preserved specimens. The point on the mental seems somewhat less conspicuous in the former species. The action of this tip in *occipitalis* indicates that there is some flexibility of the tip independent of the mental itself. There is a slot in the rostral into which this point fits, so that the aperture through which the tongue is extruded may be tightly closed.

The jaws are slightly opened when the tongue is protruded. The tongue of both species is black or dark-brown, with white tips back almost to the bifurcation. When the snake is appraising its surroundings, the tongue is vibrated through 180 degrees, from vertically upward to downward.

The pupil is round, the iris black, thus making the eye appear unicolor. *C. palarostris* may have a slightly larger eye, proportionately, than *occipitalis.*

As for intrageneric trends, the following will summarize the major differences: The form with the proportionately longest tail is typical *annulata* from Imperial and Yuma counties; the snakes of this subspecies have relatively shorter tails in the fringe areas both to the east of Yuma County, and in San Diego County to the west. *C. o. occipitalis,* alike in the Coachella Valley and in the western Mojave, is shorter-tailed than *annulata,* even shorter than the San Diego County population.

In ventral scale counts, the maxima are reached in the warmest areas, the central Colorado and Yuma deserts, the Coachella Valley, and the western Mojave. This variation conforms to the general rule that snake populations inhabiting warmer areas have more ventral scutes than individuals of the same subspecies in cooler places. The foothill snakes in San Diego County have lower counts, and the same is true of the Arizona population east of Yuma County. *C. p. palarostris, C. p. organica,* and *C. o. klauberi* have fewer ventral plates than the other groups. The subcaudals follow tail proportionalities, *annulata* being high, and *occipitalis* low, with the San Diego County and south-central Arizona populations intermediate.

The greatest variations are in pattern and colors. The snakes with the highest numbers of crossbands are those from the Coachella Valley, with the western Mojave *occipitalis* only a few below. *C. p. palarostris* has the fewest marks, *annulata* being intermedite. In the number of bands there is little difference between the Yuma, Imperial, and San Diego county populations. Farther east, in Arizona, including *klauberi,* the tendency is upward, so that the counts fall between those of *annulata* and those of *occipitalis* from the western Mojave.

In the color of the primary series of bands, *occipitalis* and *talpina* are generally brown; *annulata, klauberi, organica,* and *palarostris* black. The interspace suffusions run to yellow in *occipitalis* and to red in *annulata, organica,* and *palarostris.* Orange is occasionally observed in the western Mojave population. The most perfect *annulata* interspace reds are found in Imperial and western Yuma counties; here they are deep in color, and with even edges sharply contrasting with the white or buff ground color. Westward in San Diego County the interspace colors tend to be lighter, narrower, and less sharply bordered; at the higher elevations they are often absent. Eastward of Yuma County the interspace secondary bands become narrower and darker, reaching a climax in *klauberi,* in which the red is almost completely masked by maculations nearly as dark as the primaries. The same trend is noted from *occipitalis* northward toward *talpina,* except that in this case the maculations are brown. Both subspecies of *palarostris* have wider and deeper red secondary bands than any *annulata.*

The total dark pigmentation (whether black or brown) seems to increase at the higher altitudes. Thus, in San Diego County, the dorsal bands are wider, proportional to the interspaces, than in Imperial County, and the bands widen ventrally to a greater degree. In south-central Arizona the same tendency is manifested by increased maculations in the interspaces, plus a widening of the ventral bands; it reaches the ultimate in *klauberi.* In the same way the snakes to the north of the Mojave become darker at the higher altitudes, reaching the extreme in *talpina. C. o. occipitalis* tends, with considerable consistency, toward more dorsal but fewer ventral bands, as compared with *annulata.*

PHYLOGENY

I visualize the present geographical arrangement of the subspecies of *Chionactis* as, possibly, the result of three migrations from Sonora northward and westward. The first postulated migration was accompanied by the evolution of the brown, short-tailed snakes (*occipitalis*), of the Mojave Desert, and included an invasion of the Coachella Valley down to Lake LeConte by way of the Morongo route. *C. o. talpina* was a later northward extension and differentiation from the main *occipitalis* population in the south.

The second inferred migration, that of *annulata* into the Yuma Desert and into the Colorado Desert (except the Coachella Valley), probably occurred not long before the termination of the ancient main stage of Lake LeConte (Hubbs and Miller, 1948, p. 104). The lack of difference between the snakes of the east and west sides of what was once the bed of this lake—now represented by the East and West mesas bounding the Imperial Valley—indicates that these populations were not separated for any great length of time. The *occipitalis* tendencies observed in the San Diego County population of *annulata* suggest a merging of the two populations by reason of a drift of *occipitalis* around the southern end of the Santa Rosa Mountains during one of the Lake LeConte recessions. It seems probable that *occipitalis* was the later arrival in this area of composites since the isolated pockets, at La Puerta, for example, are nearer *annulata. C. o. klauberi* is an eastern offshoot of *annulata.*

The final invasion was that of *organica,* which has advanced to the point of producing an intrusion into the *annulata* area in the vicinity of Organ Pipe

Cactus National Monument, separating, around Ajo and Pozo Sipiano, two sections of an *annulata* population having some *klauberi* tendencies. The close similarity of the two *annulata* populations, particularly their *klauberi* peculiarities, suggests that they have not long been separated by the *organica* wedge.

ECOLOGY, LIFE HISTORY, AND HABITS

Ecological and Temperature Preferences.—As we survey the snake fauna of desert areas, we note various criteria that indicate the degree to which the several genera have become addicted to or tolerate the arduous conditions found there.

Some are clearly fringe invaders; that is, they filter into the edges of our southwestern deserts but are usually absent where the dry and barren conditions are most extreme. Typical of these are such forms as *Lampropeltis getulus* and *Lichanura roseofusca.* Others endure desert conditions, but show, by population increases when the conditions are ameliorated by agricultural development and irrigation, that it was toleration rather than preference which led them to an acceptance of the desert. Such, for example, are *Pituophis catenifer affinis* and *Masticophis flagellum piceus*, snakes that, though always present in the Imperial Valley, have increased greatly in numbers since the coming of irrigation.

Of the snakes that really thrive in the desert, some are represented by desert subspecies of much more widely distributed forms, among them *Arizona elegans*, *Rhinocheilus lecontei*, and *Crotalus scutulatus.* All three flourish in Upper Sonoran areas, *Arizona* and *Rhinocheilus* in California (and elsewhere as well), and *C. scutulatus* in Arizona.

Of those whose greatest populations—whose headquarters, as it were—are in the desert, there are three: *Phyllorhynchus decurtatus*, *Chionactis occipitalis*, and *Crotalus cerastes.* All three, as shown by roadside observations in the Coachella, Imperial, Yuma, and Blythe agricultural areas, are driven out by irrigation. And we are struck by the virtual identity of their ranges.

If we assume that *decurtatus*, *perkinsi*, and *nubilus* are all subspecies of *Phyllorhynchus decurtatus*—of which I am beginning to be rather doubtful—that species has somewhat the greatest range, for it reaches the Cape Region of Baja California, whereas the other two may not extend much below San Felipe on the Gulf coast. In San Diego County, *Phyllorhynchus* has reached San Felipe Valley, where it is found at the top of Sentenac Canyon, whereas the others stop at the bottom of the Canyon, some 4 miles farther down the slope. *Phyllorhynchus* is also found somewhat higher up the Palms-to-Pines grade in Riverside County than the other two. Yet on the Mountain Springs grade, on the San Diego–Imperial Border, *Chionactis* reaches a higher elevation than the others.

At the northeastern corner of the range, in southwestern Utah, it is probable that *Crotalus cerastes* considerably outranges the other two; on the other hand, in the Tucson area of Arizona, the *C. cerastes* range stops at Cortaro while the others continue into Tucson. The ranges of the species are imperfectly known in Sonora, but it appears that *C. cerastes* is the more restricted. But, by and large, despite these slight sorties of one or another species at the fringes, the congruence of their ranges is remarkable.

In general, these three desert snakes prefer dry and sandy areas. *Phyllorhynchus* is likely to predominate where scattered stones abound, whereas the others prefer a looser soil. Since all are small snakes, an extensive uniformity of terrain is not required; to whatever extent sand is preferred, a sufficient amount will be found in the dry washes threading their way amid rocky hills or sun-baked mesas. Areas of extreme barrenness, with an almost complete lack of vegetation, are not densely populated, probably owing to a scarcity of food. Thus we find these sand-dwellers to be rare where there is a superabundance of sand, in such places as the belt of sand hills some 17 miles west of Yuma, in Imperial County. They are virtually absent from some particularly barren stretches along the shores of the Salton Sea, although there is much sand about. The population of all three becomes more sparse as one proceeds eastward from Bensons Dry Lake, in eastern San Diego County, toward Kane Spring, Imperial County, a route along which the vegetation also becomes increasingly attenuated.

Scattered sand hummocks, crowned with mesquite or other desert shrubs, are favorite refuges of both sidewinders and shovel-noses. Hillocks of coarse sand constitute the typical habitats of sand-loving forms according to Cowles (1941, p. 125).

Since much hunting of *Chionactis* is done at night when the exact nature of the surroundings cannot be appraised, most specimens in my collection are not accompanied by ecological data. However, the following records will indicate the frequency of different surroundings under some rather broad generalizations:

Sandy desert	55
Barren desert	54
Brushy desert	39
Rocky desert	6
Grassy desert	3

Some of the particular situations noted were: Date grove, rocky gorge, creosote bush, burro weed, mesquite hummocks.

One of the earliest experiences that I had in *Chionactis* collecting was on the night of April 30, 1927, when 8 of us, with flashlights and Coleman lamps, hunted the mesquite hillocks in the vicinity of the old San Felipe Hotel in eastern San Diego County for two hours or more. We secured 3 of these little snakes, a meagre catch for the effort, and far less than would have rewarded the road-collecting method that was first tried a year or so later. The dark crossbands of these little snakes are admirably suited to blend with the shadows of the twigs scattered about on the sand, and we found them difficult to discover. On a dark, smooth pavement, picked out by the headlights of a car, they have no such protection.

These little snakes are sometimes trapped in fresh road tar. Hubbs and Walker (1947, p. 464) reported finding 3 in a stretch of 5.8 miles of road in the eastern Mojave Desert, among many other creatures snared the night before.

The air temperatures at which *Chionactis* has been found active on the roads at night are indicated in the following table:

Air Temperature degrees F.	Number of specimens *C. o. occipitalis*	*C. o. annulata*
62-3		1
64-5	2	2
66-7	1	6
68-9	1	3
70-1		5
72-3	2	9
74-5	5	10
76-7	1	11
78-9	7	6
80-1	4	13
82-3	2	16
84-5		12
86-7	1	9
88-9	1	8
90-1		3
92-3	2	5
94-5		3
96-7	1	3
98-9	1	
	31	125

The collecting times were as follows:

Time When observed	Number of specimens *C. o. occipitalis*	*C. o. annulata*
5:00- 5:29 P.M.		1
5:30- 5:59		
6:00- 6:29		1

6:30- 6:59		1
7:00- 7:29	4	7
7:30- 7:59	7	14
8:00- 8:29	4	34
8:30- 8:59	8	31
9:00- 9:29	4	26
9:30- 9:59	2	21
10:00-10:29	1	17
10:30-10:59	2	9
11:00-11:29	1	4
11:30-11:59		3
12:00-12:29 A.M.	1	1
12:30-12:59		
1:00- 1:29		
1:30- 1:59		
2:00- 2:29		1
2:30- 2:59		
	34	171

These records indicate that *Chionactis* is most active at air temperatures between 70° and 90° F., and from 7:00 to 10:00 P.M., but certain cautions respecting the interpretation of the tables are necessary. As those of us who have written on the habits of our southwestern reptiles have frequently pointed out, the recorded air temperature is only an approximate indication of the temperature of the snake's body, for the creature is in contact with the ground and is subject to conduction of the ground temperature, and it is partly protected from the convection effect of the wind. In early evening, particularly in spring, the ground is almost invariably warmer than the air. It is probable that the snakes are abroad partly because of this fact.

As to the time of activity, though it is unquestionably true that in the spring the snakes avoid the late hours when the temperature is suboptimum, the lack of late-hour records in the summer, when such hours are likely to be most suitable in temperature, is merely the result of inadequate collecting, for our collecting forays rarely extend beyond midnight.

Our records certainly do prove definitely that all forms of *Chionactis* are almost exclusively nocturnal, for I have driven thousands of miles on desert roads in the daytime, and, in contrast with the many specimens recorded alive at night, those active diurnally have been rare enough to warrant individual mention. I found one on the east base of a large mesquite hummock at 6:10 P.M., just as the sun was cutting the horizon. This was in Imperial

County, 4 miles west of Kane Spring Junction, April 20, 1935. A week later another was caught crossing the road at 5 P.M., in bright sunlight, 1 mile west of Grays Well, Imperial County. Charles E. Shaw found a *C. o. annulata* crossing the road at 9:40 A.M., May 14, 1947, 20 miles southwest of Pozo Sipiano, Sonora. The air temperature was 69° F. and a strong wind was blowing. He also found a juvenile issuing from a hole near Clark Dry Lake, San Diego County, at 5:10 P.M., when the sum was still shining brightly. This was in the early spring, on March 29, 1941. Dr. R. B. Cowles informs me that in many hundreds of desert trips he has seen *Chionactis* abroad in the daytime only twice. After sundown catching them is not so unusual, yet even in the spring they do not reach maximum activity until dusk has turned to darkness.

That these little snakes reach their maximum activity in the early evening in the spring, when the later temperatures are much below the optimum, is easy to demonstrate, for the live specimens are found during the early hours, while later only DOR's remain as evidence of their earlier prevalence. In summer the best temperature conditions are undoubtedly reached just before sunrise, for, earlier in the evening, ground and air temperatures are too high for comfort and may even be lethal. However, so little collecting has been done after midnight in summer that we cannot say whether there is any considerable early-morning activity at that season. Since the snakes' prey is also forced to adopt a subterranean existence, food, to the limited extent that it is required, may be found below ground, without the risk of surface activity. Collecting up to midnight on several hot nights in June, C. B. Perkins had meagre results, but next morning a number of DOR's were found, indicating that there had been an accelerated post-midnight activity.

Although statistics based on air temperatures are not trustworthy proofs of optimum body temperatures, I should judge from field and laboratory experiences with *Chionactis* that such temperatures are probably in the range of 26° to 28° C. (78.8° to 82.4° F.). Cowles and Bogert (1944, p. 286) report the highest voluntarily accepted temperature in captivity as 31° C. (87.8° F.), the critical maximum at 37° C. (98.6° F.), with recovery appearing at 33° C. (91.4° F.). Under laboratory conditions, the snakes lost the power of co-ordinated action at 38° C. (100.4° F.). The minimum voluntary tolerance is given as 20° C. (68° F.).

The desert is usually windy on spring nights, but this does not completely discourage the nocturnal forays of these little snakes. I find among my notes the following designations of wind conditions at the time of the capture of *Chionactis* on the road: Windy, very windy, hard wind, strong wind, cold strong wind. Occasionally one sees these and other little snakes blown across the road, so strong is the gale.

Although specimens of *Chionactis* have been brought to the San Diego Zoo or Natural History Museum during every month of the year, it is probable that those representing the months of November to February, inclusive—about a dozen in 27 years—were not indicative of surface activity, but were dug out of their winter refuges in the course of agricultural or road work.

Probably a better criterion of seasonal activity is furnished by the following table showing when specimens have been found alive or dead on the road at night:

	Number of specimens	
Month	*C. o. occipitalis*	*C. o. annulata*
January		
February		
March		4
April	2	16
May	75	161
June	49	107
July		23
August		5
September		5
October		2
November		
December		
	126	323

Of course, these figures, like our other statistics, are premised on the coincident activities of snakes and collectors, and it must be admitted that collecting is neglected in seasons other than spring. However, the reason for our summer inactivity is mainly the result and not the cause of the strong spring peak, for experience soon taught us that collecting was virtually fruitless after the end of June.

A more accurate criterion of relative seasonal activity may be derived from statistics of the shovel-noses encountered on the road (dead or alive) per mile of night travel. The following statistics are based on 20,768 miles of travel on desert roads at night in the months of March to October, inclusive, during which 324 specimens of *Chionactis* were recorded.* The resulting statistics in snakes per 100 miles of travel are:

Month	Specimens of *Chionactis* per 100 miles
March	.00
April	.47
May	2.00
June	2.09
July	.86
August	.69
September	.27
October	.00

*The difference between the total number of snakes listed in this and the previous table results from the fact that the first table includes data on snakes found on night trips when mileage records were not kept.

It will be seen that there is a sudden rise in activity in May and June (the actual peak is probably during the first week of June), followed by a decline through the rest of the summer. Our experience indicates that the season is somewhat earlier in the Borrego area of eastern San Diego County than in the Mojave Desert. At the peak season in Borrego, and under favorable conditions of weather, the take will often exceed 10 shovel-noses per 100 miles of desert travel. The much lower average values result from unfruitful trips during the many unseasonable cold nights that are encountered on the desert in spring and early summer.

That autumn collecting is unrewarding, even when spring weather conditions are duplicated, has lately been verified by Charles E. Shaw. He cruised the road between Scissors Crossing and Bensons Dry Lake, in the Borrego area of eastern San Diego County, at weekly intervals from early spring to autumn. He found the road to be virtually barren of snakes on the autumn nights (2 snakes in 138 miles of travel on Sept. 23, 30, and Oct. 7) compared with the spring nights (40 snakes in 138 miles, on May 27, June 2 and 8), notwithstanding a similarity in temperature and other weather conditions. These statistics refer to snakes of all kinds, not *Chionactis* exclusively.

As an indication of the concentration sometimes reached, it may be noted that Shaw and the writer collected 10 specimens of *C. o. annulata* in 17 miles along the Yaqui Well–Bensons Dry Lake road in the Borrego area of eastern San Diego County on June 9, 1939. The best Mojave Desert record was made in the Mojave–Kramer–Adelanto area, where Shaw found 10 individuals of *C. o. occipitalis* in 43 miles of travel, on June 5, 1949. The following night 8 were taken.

William R. Supernaugh, Superintendent of Organ Pipe Cactus National Monument, reports that the *C. p. organica* specimens collected in that vicinity were found prior to June 20 and between the hours of 8:30 and 9:45 P.M.

I believe that *Chionactis* is somewhat less tolerant of unfavorable nocturnal weather conditions in the spring than are the other, larger common snakes of the desert, namely, *Rhinocheilus*, *Arizona* and especially, *Crotalus cerastes*.

Our collecting experiences on the desert indicate that all these nocturnal snakes prefer the dark of the moon to moonlight, though the available statistics do not yet supply absolute proof of this theory.

Relative Populations.—In many desert areas, *Chionactis* is one of the commonest snakes. The following statistics indicate the relative frequency of occurrence of the 5 most plentiful nocturnal snakes found in three desert areas of southern California, as indicated by records of specimens observed alive or dead on the road during the past 20 years:

WESTERN MOJAVE DESERT

Crotalus cerastes cerastes	132
Arizona elegans candida	96
Rhinocheilus lecontei lecontei	86

Crotalus scutulatus scutulatus	79
Chionactis occipitalis occipitalis	61

COACHELLA VALLEY, RIVERSIDE COUNTY

Crotalus cerastes laterorepens	59
Phyllorhynchus decurtatus perkinsi	51
Arizona elegans eburnata	50
Chionactis occipitalis occipitalis	42
Rhinocheilus lecontei clarus (or *lecontei–clarus* intergrades)	15

BORREGO AREA, SAN DIEGO COUNTY

Phyllorhynchus decurtatus perkinsi	523
Chionactis occipitalis annulata	397
Crotalus cerastes laterorepens	196
Arizona elegans eburnata	153
Rhinocheilus lecontei clarus (or *lecontei–clarus* intergrades)	105

The numbers of specimens recorded from the different areas are not to be taken as indicating the relative snake concentrations between districts; the high records from the Borrego area merely represent many more trips than were made to the Mojave or Coachella sections.

It will be observed that *Chionactis* falls within the first 5 in each area. It is probable that this small snake (and *Phyllorhynchus* as well) represents a somewhat higher percentage of the snake population than these figures indicate, since the small snakes are more likely to be overlooked, whether alive or dead, than the larger forms, *Crotalus, Arizona,* and *Rhinocheilus.*

Of course, these figures involve generalities based on areas of considerable extent and ecological diversity. Within these areas there are smaller, more uniform sections in which one or another species may predominate. For example, there is a short stretch of road at the top of the Sentenac Canyon, in San Diego County, where the worm snakes (*Leptotyphlops humilis* in the form of *L. h. humilis–cahuilae* intergrades) are exceedingly common, far outnumbering all other snakes taken together.

So it is with the other small desert snakes. It is probable that the *Chionactis* population exceeds *Phyllorhynchus* in the sandier sections of the Colorado Desert. For example, Cowles (1941, p. 134) reported that in an area of sand hummocks on the northeast side of Coachella Valley, out of 96 reptiles (including lizards) excavated by land grading operations during the season of hibernation, 41 were *C. o. occipitalis.* This census, probably representative of the population, indicated this snake, locally, to be much the most common form.

Locomotion.—Normally *Chionactis* uses the horizontal undulatory type of locomotion. In soft sand it leaves a sinusoidal track with wide side loops.

The sand is piled up on the rearward edge of each crest, so that it is easy to determine the direction of travel. Mosauer (1932, p. 77) pointed out that during motion the ventral plates are drawn in through action of the abdominal muscles and that this serves both to form a concave ventral surface and to sharpen the angle formed by the ridge at the outer ends of the ventrals, this ridge being characteristic of the genus. The ridge is thought to facilitate motion in the sand by reducing side slippage.

Chionactis will sidewind if badly frightened or stimulated by the discomfort of an uncomfortably warm surface. It will also attempt this type of locomotion on a smooth surface such as glass or paper. The loops formed are not as deep as those of the sidewinder (*Crotalus cerastes*), and though the writhing is rapid, the motion is not particularly effective in net travel. Even so, on the smooth surface of a paved desert road, *Chionactis* is more often successful in escaping than any other night snake encountered.

In its nightly cruises, it is evident that *Chionactis* spends most of its time on the surface. Although it can burrow with rapidity, and can progress below the surface of sand with good efficiency, it will not normally seek to escape by burrowing, as do some other sand-dwellers, *Chilomeniscus* and *Anniella* for example. Placed in a box containing yielding sand it will spend much time crawling about on the surface searching for a chance to escape up the sides. In so doing, the anterior part of the body is raised well above the ground, so that only the posterior part is used for progression.

These observations of locomotion are equally applicable to *occipitalis* and *palarostris*. Although the latter has a blunter snout, it was observed on several occasions to enter sand quite rapidly and with little apparent effort.

Fossorial Activity.—Mosauer (1932, p. 77) first expressed the opinion that *Chionactis* travels only short distances on the surface, spending more of its time in the sand, where it crawls below the surface using a horizontal undulatory motion. But later (1933, p. 15; 1935, p. 20; 1936, p. 13) he decided that most, if not all of its night cruising is done on the surface, as it travels from one shrub-covered hillock to another. He doubted whether more than 100 feet was usually covered in one night. Mosauer's observations were based on tracks, and it is now known that *Chionactis* tracks cannot always be distinguished from those of other small desert snakes, as has been verified by Cowles (1941, p. 139). However, there is no reason to doubt Mosauer's conclusion that although *Chionactis* burrows quite readily and efficiently in sand, often spending the day thus buried, and though it progresses through sand with ease, it does not normally move for as great distances below the sand surface as do some sand-dwellers among the snakes.

In seeking refuge in the daytime, *Chionactis* does not always burrow in sand; it may take to mammal holes or hide under debris. I have found shovel-noses under stones, boards, and cardboard signs. Wade Fox, Jr., advised me that he had dug two specimens from holes, an *occipitalis* near Garnet, Riverside County, and an *annulata* in the Sand Hills, 14 miles west of Winterhaven, Imperial County. He found them by following the tracks that showed in which burrows the snakes had taken refuge. He judged the holes to have been made by scorpions.

These little snakes are frequently plowed out during road work or land-leveling for agriculture, but in such cases it is usually impossible to tell whether they had been down holes or buried in sand. Cowles (1941, p. 134), in the experience previously mentioned, reported that the 41 specimens of *Chionactis* were taken during 4½ days of brushing or rough grading of hummocks and small sand dunes with a tractor and scraper near Edom, Riverside County. This was in the early spring during the season of hibernation. The depths of the few specimens whose location could be determined varied from 2 feet to only an inch. Most of them were within a foot of the surface.

More recently Cowles has stated (letter of March 3, 1949): "As I suggested in one of my earlier papers, we discovered that *Chionctis* inhabits the warm, near-surface layers of the sand during the daytime, and thus secures ideal temperatures in total darkness. The snakes were found 2 or 3 inches below the ground surface, at temperatures varying from 26° to 28° C. (78.8° to 82.4° F.)." In another letter, Dr. Cowles remarks: "We caught *Chionactis* through a new technique of raking down the warm surface of the sand early in the Spring and I think that, properly applied, it might be a profitable method for collecting spade-nosed snakes." This suggests a sort of subterranean basking that is even more efficient and certainly safer than surface basking, when air temperatures are below the optimum and a reptile seeks the benefits of direct solar radiation. For, by this habit there is no loss of heat through convection—particularly important if there be a breeze—and the decline in temperature from the surface downward permits the choice of whatever depth will produce the most comfortable body temperature.

The methods of burrowing used by *Chionactis* may be readily observed with captive specimens, especially when kept in a box with one glass side. First, it will be noted that the snakes do not immediately seek refuge in the sand; on the contrary, they may crawl about on the surface for an hour or more before going below. They cannot be frightened into the sand. However, if they once go into the sand, and then are disturbed by a probe jabbed near them, they will move elsewhere in the sand without emerging. If picked up and the fore part of the body is stuck into the sand, the snake will usually go in. Once in the sand, a snake will often remain for hours at a time. When crawling below the surface, *Chionactis* usually progresses at a depth of an inch or so; faint movements of the sand surface can often be seen, but the snake is too deep to leave a surface track as does *Chilomeniscus*, which often crawls just below the surface. Shovel-noses progress in the sand by an undulatory motion and seemingly with little more effort than when on the surface; the polished scales are no doubt a favorable factor in this type of locomotion, as pointed out by Mosauer (1935, p. 20). *Chionactis* can back up in sand without difficulty. If a snake has been buried in the sand and is dragged to the surface, it will usually crawl about the cage without going into the sand again. When watching the snakes through a glass sidewall of a cage, some will be seen to descend to a depth exceeding 6 inches.

Food.—I have records of scorpion, centipede, and insect remains in *Chionactis.* Richard Schwenkmeyer has advised me that, in his studies of the stomach contents of southwestern reptiles, he found the following in *annulata*: *Uta* (egg containing an embryo), Blattaria (Phyllodromidae), spiders, abdominal plates of Coleoptera, Coleoptera larvae, Hymenoptera (Formicidae), Lepidoptera pupa, unidentifiable insect pupa. Cowles (1941, p. 134) reported one that contained some form of Blattidae; in 1949 (p. 212) he stated that the diet comprises insects and other arthropods, including fairly large and powerful scorpions. Captive specimens ate centipedes. David Regnery found that shovel-noses would eat termites offered on the end of a stick. The type specimen of *palarostris* contained a large spider.

Charles E. Shaw has devised a successful method of keeping *Chionactis* alive in captivity. He reports:

> "At the Reptile House of the San Diego Zoo specimens of *Chionactis occipitalis annulata* are kept in a glass terrarium measuring 20 in. × 10½ in. × 10 in. A glass partition 7 in. high is inserted transversely to separate one-third of the tank from the remainder. About 6 in. of sand are placed in this smaller compartment, while the rest of the tank is filled with 6 in. of yellow cornmeal well stocked with mealworms (*Tenebrio molitor*). *Chionactis* will eat the larvae and pupae of *Tenebrio.* The snakes are liberated on the sand and are provided with cover in the form of a small board under which they may conceal themselves without burrowing, if they prefer. Most of the time, however, they remain beneath the surface of the sand. The snakes have no difficulty crossing the one inch of glass partition which extends above the surface of the sand and cornmeal and serves primarily to discourage the mealworms from crossing over into the sand. Kept in the manner described, 2 adults of *Chionactis o. annulata* are still in good condition after 36 months in captivity."*

It is somewhat difficult to cause *Chionactis* to drink; however, it will do so if the head be held under water.

Reproduction.—I have examined 7 females that contained enlarged eggs, the number varying from 2 to 4, average 3.1. The smallest gravid *annulata* measured 289 mm. (11⅜ in.). The largest eggs measured 14 × 4½ and 13 × 5 mm. Cowles (1941, p. 134) reported one *occipitalis* containing 6 and another 9 ova. A specimen of *organica* contained 4 eggs.†

On May 27, 1939, a live male *C. o. occipitalis* was found hovering over a DOR female as if endeavoring to mate. This was at 8:41 P.M., air temperature 24° C. (75.2° F.).

Defense.—When annoyed *Chionactis* stands its ground and lunges forward violently and repeatedly from a striking coil. Sometimes the mouth is

*One of these was still alive at 42 months.

†I find no evidence of embryos as suggested by Hensley, 1950, p. 283. *Chionactis* is probably oviparous.

opened at the end of the strike, but often not. In daylight it can hit one's finger with considerable accuracy and will even follow it about, striking continuously. Presumably the strike might intimidate a small creature; the teeth are much too small to puncture the skin of one's hand. As do many other snakes, *Chionactis* sometimes voids excrement when handled.

Little is known concerning the senses of *Chionactis*. It can see well in bright light, since it will strike at a finger with fair accuracy, and will dodge hand movements. It can see such motions at a distance of a foot in dim light.

Enemies.—Presumably *Chionactis* is preyed upon by *Lampropeltis, Salvadora, Rhinocheilus,* and *Arizona,* which feed on snakes, among other kinds of food. Owls and coyotes may be assumed to eat them. One was killed by a tame cat at La Puerta. I have only one definite record of a shovel-nose becoming the prey of a wild creature; at Palm Springs Station, Riverside County, a red racer (*Masticophis flagellum piceus*) was found that had swallowed an adult *Chionactis o. occipitalis.* It is not known whether this diurnal snake had caught an early shovel-nose above ground, or had found it down a hole.

A KEY TO THE GENUS *Chionactis*

1a Snout convex above; dark bands on the body usually fewer than 21; bands on the body plus unmarked anterior band positions on the ventrum usually fewer than 23* — *C. palarostris*

(for subspecies continue on to 2)

1b Snout flat-topped; dark bands on the body usually 21 or more; bands on the body plus unmarked anterior band positions on the ventrum usually 23 or more* — *C. occipitalis*

(for subspecies continue on to 3)

2a Black bands on the body fewer than 12, and less than half as wide (middorsally) as the interspaces; more than 8 scales (end-to-end) between the parietals and the anterior edge of the first black body band — *C. palarostris palarostris*

West-central Sonora, Mexico

2b Black bands on the body more than 11, and more than half as wide (middorsally) as the interspaces; fewer than 9 scales (end-to-end) between the parietals and the anterior edge of the first black body band — *C. palarostris organica*

Southwestern Pima County, Arizona

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*The first criterion will place most specimens. If the dark body bands number 18 to 22, however, the second criterion should be used, as it will result in a higher accuracy of determination. With either criterion, tail bands are not included.

3a Definite black or brown secondary bands in the interspaces between the primary bands, usually with scale centers maculated, and often crossing the dorsum 4

3b Without black or brown secondary bands in the interspaces between the primary bands, such dark marks as there are being usually restricted to scale edges and rarely evident dorsally 5

4a Primary bands black or very dark-brown; ventrals usually fewer than 152 in males and fewer than 160 in females. *C. occipitalis klauberi*

Southwest Maricopa, and Pima and Pinal counties, Arizona

4b Primary bands brown; ventrals usually 152 or more in males and 160 or more in females *C. occipitalis talpina*

Tonopah–Indian Springs area of Nevada, and southwesterly into the Death Valley region of California.

5a Dark bands on the body plus unmarked anterior band positions on the ventrum usually fewer than 45; bands usually black or almost black *C. occipitalis annulata*

Eastern San Diego, and western and southern Imperial counties, California; Yuma, western and southern Maricopa, and northwestern Pima counties, Arizona; and northeastern Baja California and northwestern Sonora, Mexico.

5b Dark bands on the body plus unmarked anterior band positions on the ventrum usually 45 or more; bands brown *C. occipitalis occipitalis*

The Mojave Desert, including southwestern Inyo, eastern Kern, northeastern Los Angeles, and San Bernardino counties in California; also desert part of Riverside County and northeastern Imperial County, California; southern Clark County, Nevada; and southwestern Mohave County, Arizona.

SUMMARY

This is a survey of the shovel-nosed snakes of the genus *Chionactis* (Colubridae), small nocturnal snakes inhabiting sandy areas in the deserts of the southwestern United States and northwestern Mexico. There are 2 species, *C. occipitalis* and *C. palarostris*; *C. occipitalis* is, in turn, divided into 4 subspecies: *occipitalis, annulata, klauberi,* and *talpina.* The latter, occurring in southern Nevada and the Death Valley region of California, is newly described. *C. palarostris* comprises 2 subspecies, *palarostris* and *organica.* The latter is a new subspecies found in the Organ Pipe Cactus National Monument of southern Arizona. Relationships are discussed and life-history notes given.

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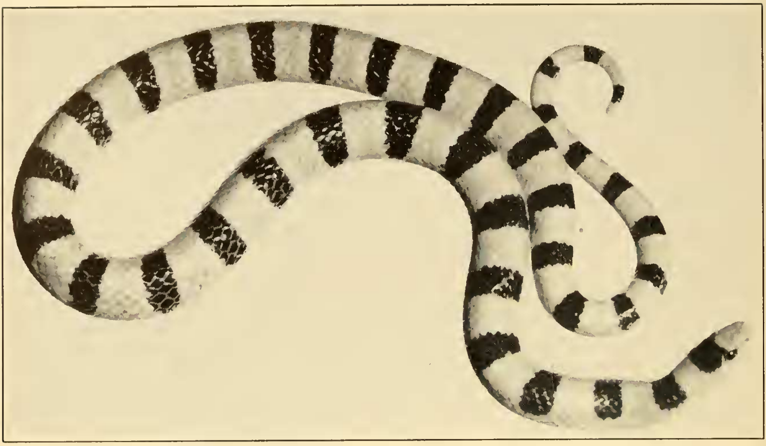

Fig. 1. *Chionactis occipitalis occipitalis* Mojave Desert Shovel-nosed Snake
Adult male from the Alvord Mountains, San Bernardino County, California.

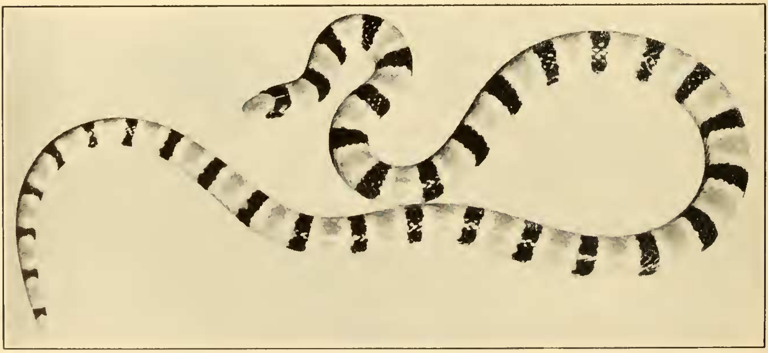

Fig. 2. *Chionactis occipitalis annulata* Colorado Desert Shovel-nosed Snake
Adult male from 2 miles south of Clark Lake, Borrego Valley, San Diego County, California.

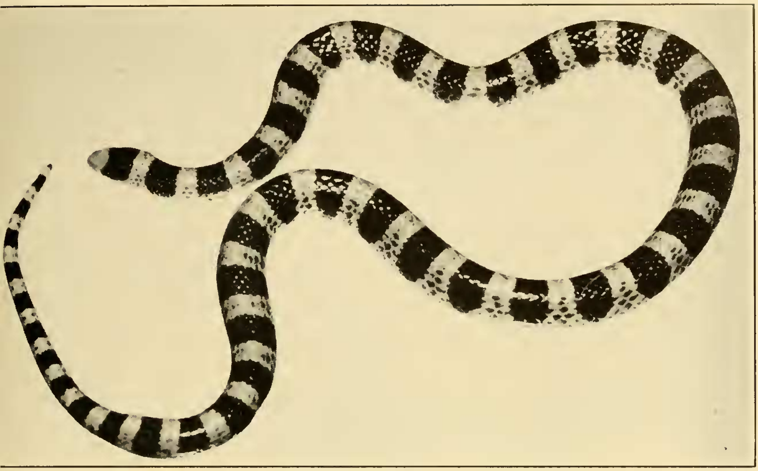

Fig. 1. *Chionactis occipitalis talpina* Northern Shovel-nosed Snake
Adult female from 10 miles north of Goldfield, Esmeralda County, Nevada.

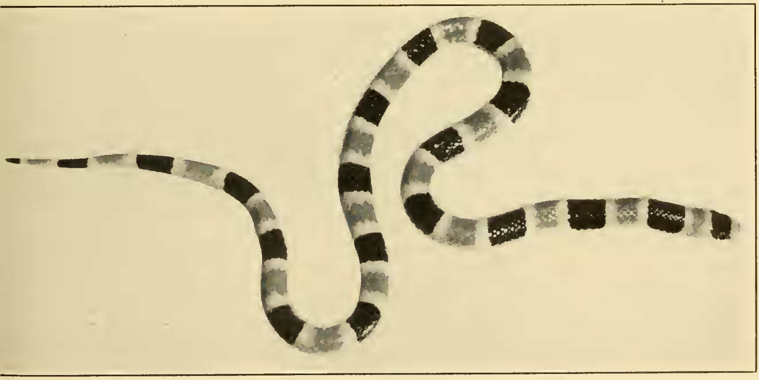

Fig. 2. *Chionactis palarostris organica* Organ Pipe Shovel-nosed Snake
Adult male from 9 miles north of U.S.–Mexican Boundary on Ajo–Sonoyta road, Pima County, Arizona (type specimen).